SECTION 02850

LIGHT AND HEAVY RAIL TRANSIT

BALLASTED TRACK CONSTRUCTION

PART 1 - GENERAL

0.1 DESCRIPTION

A. Work Included: This Section specifies light rail transit and heavy rail transit ballasted track construction of running rail and third rail on ties, track ballast, and subballast.

B. The Contractor shall provide all necessary labor, equipment, and materials to be incorporated into the work on tracks as indicated on the Contract Drawings and in these specifications.

C. All track construction and materials shall be in accordance with the current version of AREMA Manual for Railway Engineering (AREMA MRE) recommended practices, unless otherwise indicated. References in this section are to the 2020 AREMA MRE.

D. Track construction operations shall be limited to the time allotted as specified in the Construction Specifications.

E. Where installation of welded rail is performed, thermal adjustment shall follow initial surface and alignment.

F. Work shall also include furnishing and installing special trackwork, noise and vibration mitigation, and insulated joints.

G. Ballasted track construction as shown and defined in the contract documents includes the removal and installation of track to complete the Work including:

1. Smoothing, grading, and compacting subballast surface, as required
2. Installing noise and vibration mitigation components, as required
3. Placing and compacting ballast
4. Placing and aligning ties, including replacing and plugging of ties
5. Distribution and placing of rail, including continuous welded rail (CWR)
6. Spiking and/or clipping tie plates
7. Thermal adjustment and destressing of new and existing CWR
8. Installing bolted, bonded, and/or welded rail joints
9. Tamping, gauging, aligning, and surfacing of track
10. Installing special trackwork, third rail, and other track appurtenances
11. Removal, reinstallation, and/or disposal of all materials and items which interfere with rehabilitation and construction, including timber ties, rail, and OTM.

H. The above construction includes all pertinent trackwork labor, equipment, and materials associated with track construction such as welds; bonded insulated joints; rail cutting and stress adjustment; tamping, surfacing, aligning, and gaging; and all other work necessary to construct a completed and MBTA approved track structure.

I. Related work specified elsewhere includes:

1. Section 00700 – GENERAL CONDITIONS
2. Section 02300 – EARTHWORK

0.2 SUBMITTALS

A. General

1. Certificates of Compliance shall be provided for all materials furnished by the Contractor.
2. Submit shop drawings of all major track material components for review and approval by the Engineer.
3. Submit layout plans showing rail types, continuous welded rail (CWR) lengths, buffer rails, insulated joint locations, and field welds.
4. Submit names and locations of proposed suppliers for subballast, track ballast, ties, rails, and all other materials and products being installed under this Contract.
5. Submit samples of materials as required by the Authority.
6. A detailed description of the methods and procedures to be used in the execution of Ballasted Track Construction as specified herein, including:
    a. Proposed construction procedures for ballasted track removal and installation, including tie installation, and track surface and alignment.
    b. A tie, timber, and steel rail plan for the entire trackwork alignment to include all ballasted track and special trackwork, including the location of all rail joints, welds, rail lengths, and ballasted track sections to be installed.
    c. Proposed construction and installation methods and procedures for panelizing track at locations where panelized track will be used as determined by the contractor.
7. The Contractor shall furnish for review and approval by the Engineer the type of tamping, aligning, and compacting equipment to be used for surfacing and aligning ballasted track.
    a. In general, the Contractor shall provide a tamper as described in Article 3.6.F.2.a that is capable of tamping and aligning the ballasted trackwork.
    b. The Contractor shall provide one or more ballast regulators with brooms, plows, and wings capable of shaping the ballast section and dressing the ballast per the specification.

c. The contractor shall provide one or more dynamic track stabilizers capable of compacting the ballast section and with a dynamic vibratory range of 0-50 Hertz and a maximum vertical load of 100 kips.

B. Construction Equipment

1. The contractor shall prepare a list of rail-borne equipment to be used during the trackwork construction. The list shall be submitted to the Engineer for acceptance at least fifteen (15) days prior to the start of work and shall include the name of the manufacturer, dimensions and weights of the equipment, and the intended use of each of piece of equipment.

2. The wheel contours and gauge of all rail-borne equipment shall be submitted for approval prior to being used during the Work.

3. Prior to accessing the railroad right-of-way, the contractor shall coordinate access points along the track corridor(s) being worked on. As necessary to mount construction equipment larger than a passenger vehicle, the contractor may be required to install temporary access roads and/or temporary grade crossing surfaces for access along the railroad. Approval from the Authority is required prior to constructing and utilization of access points.

4. All costs for installation, maintenance, removal, and permits required to install temporary access roads shall be borne by the contractor at no additional expense to the Authority.

C. Track Ballast and Subballast

1. Submit gradation reports of representative samples of the material furnished together with certification that the material meets the requirements of this specification.

2. Submit a detailed description of the methods and procedures to distribute, tamp, regulate, stabilize, and compact ballast for track work.

3. Submit type and specifications for equipment to be used in the placing, compacting, and tamping of track ballast and for aligning of track.

4. Submit charts and reports from tamper/liner for all curves adjusted as part of the Work.

D. Timber Ties

1. Submit the name of the tie manufacturer, the name(s) and location(s) of the sawmill, the seasoning yard and the treatment plant.

2. Submit description of manufacturer's equipment, type, age and present condition. Particular attention shall be made concerning equipment used to artificially season ties, if proposed. Gauges and thermometers on seasoning and treatment equipment shall have been calibrated within six months of the date of seasoning and treatment.

3. Submit product data for ties to be furnished including wood species proposed and the quantities of each.

4. Submit shop drawings of all tie layouts showing appropriate dimensions and spacing of timber switch ties.

5. Furnish to the Engineer a record of the detailed procedure for the treatment of timber ties in accordance with AREMA Manual, Chapter 30, Part 3, Sections 3.6 and 3.7.

6. Submit a copy of the timber tie fabrication plant's quality control program not less than 30 days before the start of preservation treatment.

7. Prior to shipment, the manufacturer shall submit certified inspection and test reports specified in the AREMA Manual.

8. Contractor shall provide the time and location for delivery of ties. Ties shall be unloaded and stockpiled suitable for inspection of ties by the Authority.

E. Steel Rails

1. Submit the name and location of the steel mill.

2. Submit identity and qualifications of certified independent testing laboratory that will perform rail inspection and testing at the mill during manufacturing. Prior to testing, submit rail inspection and testing procedures to the Engineer for review and approval.

3. Submit the documentation required in AREMA Manual, Chapter 4, Section 2, Part 2.1.14 - Acceptance for new rail prior to rail shipment.

4. A rail mill certificate shall be furnished containing the following data:

   a. The identity of each rail in a charge by heat, ingot, and letter.

   b. The identity of each equivalent sample by heat.

   c. The dates of all phases of heat treatment for each charge.

   d. A listing of the accepted and rejected rail in each charge.

F. Other Track Materials (OTM)

1. Submit proposed OTM samples, shop drawings, material certifications, product data, and manufacture’s installation recommendations to the Authority for approval. No materials shall be ordered or installed prior to approval by the Authority. Any Contractor furnished materials which are installed in track and subsequently found to be defective shall be replaced by the Contractor at no additional cost to the Project.

2. OTM shall include but not be limited to: track spikes and rail fasteners; tie plates; track bolts, nuts, and washers; restraining rail fasteners, restraining rail spacer block assemblies, joint bars, compromise joint bars, rail anchors, rail clips, insulating tie plate pads, and insulating bushing washers.

G. Coal Tar Epoxy

1. Submit product data for coal tar epoxy.

2. Submit application procedures for coal tar epoxy.

H. Special Trackwork

1. Submit complete shop drawings of all components of each type, prior to fabrication of special trackwork items. Show on the working drawings shop details, track centers, and layouts of special trackwork.

2. All castings shall have radiographic testing performed in accordance with MBTA and AREMA specifications. Records of all required testing, including test reports and results shall be submitted.

3. Submit Quality Control Plan for review prior to fabrication. The Quality Control Plan shall address fabrication, testing procedures, pre-assembly procedures, and process for addressing defects.

4. Submit qualifications of the Independent Testing Agency for review and approval.

5. Submit schedule indicating material pre-assembly dates and delivery dates for each unit.

6. Submit a detailed description of the methods and procedures to be used in the construction of special trackwork as specified herein, including:

   a. Proposed construction and installation procedures for removal and/or installation of special track work components as specified in the Contract Drawings, including tie installation as well as track surface and alignment.

7. Submit test results required for the work specified in this Section.

8. Furnish 12 steel spring washers of each size and diameter proposed for use in the fabrication of special trackwork, for testing by the Engineer.

I. Insulated Joints

1. Submit complete insulated rail joint shop drawings. Include calibration certificates for all testing equipment used to perform tests on insulated joints. Also submit working drawings showing the locations of insulated rail joints to be cut into CWR for review and acceptance prior to the commencement of work.

2. Submit complete bonded insulated joint plug rail shop drawings. Include calibration certificates for all testing equipment used to perform tests on insulated joints. Also submit working drawings showing the proposed method and equipment for handling and installing bonded insulated joint plug rails, locations of field welds in CWR, and lengths of bonded insulated joint plug rails for review and acceptance prior to the commencement of work.

J. Third Rail

1. Submit complete third rail assembly detailed drawings of composite low resistance rail sections listing length, weight in pounds per yard, ampacity, and guaranteed resistance in ohms per thousand feet. Include details of proposed rail joints, end approaches, and feed cable terminal pads.

2. Submit third rail insulator detailed drawings including material specifications, configurations, methods of attachment to concrete or wood ties as applicable, sizes and locations of fasteners and hardware, and the essential dimensions of insulator heads supporting the third rail and end approaches in relation to the track running rails.

3. Furnish sample of composite third rail.

4. Submit certified mill test reports on the third rail steel and aluminum.

K. Welding of Rail

1. Flash Butt Welding (Pressure)

a. Submit welding plant or mobile welding unit company name.

b. Prior to production welding, submit proper certification that each shop weld will be warranted by the Contractor against workmanship or alignment defects.

c. Submit a list of all equipment and calibration methods, method of rail end alignment, method of rail straightening, and a schedule of lengths of rail strings to be fabricated. The schedule of lengths of rail strings shall include the location of any insulated joints within the string.

1) Insulated joints shall be installed at all locations as shown on the Contract Drawings.

d. Submit ultrasonic inspection procedure, equipment description, and calibration methods.

e. Submit ultrasonic inspection records for each weld.

f. Submit procedure for dry powder magnetic particle inspection.

g. Submit magnetic particle inspection records for each weld.

h. Testing Laboratory: Employ an independent testing laboratory which shall perform all indicated weld testing. Submit certification documents for individuals conducting the weld testing.

i. Submit Quality Control procedures to be followed.

2. Thermite Welding (Exothermic)

a. Submit, prior to initiation of field welding, a detailed specification of proposed method and procedure for thermite welding. The method and procedure specified shall comply with that of the weld kit manufacturer. Include name of manufacturer and manufacturer's requirements and details for the following:

1) Rail preparation;

2) Rail spacing and tolerances;

3) Rail alignment;

4) Placing and bolting of molds;

5) Preheating rail, including temperature, method, and time;

6) Crucible tapping procedures, including duration of weld and cooling time; and

7) Trimming and grinding of weld at red heat.

b. Submit field welders' qualification certifications and certified laboratory test results for thermite welding tests specified under Article 1.3 “Quality Assurance”.

c. Record of Thermite Welds: Maintain a complete and current record of all thermite welds and their locations consistent with the form provided at the end of this Section.

d. Submit ultrasonic inspection procedure, equipment description, and calibration methods.

e. Submit ultrasonic inspection records for each weld.

f. Submit procedure for dry powder magnetic particle inspection.

g. Submit magnetic particle inspection records for each weld.

h. Keep and make available records of daily calibration of ultrasonic inspection equipment.

i. Keep and make available inspection records of each weld for straightness as per AREMA requirements.

j. Submit details of the equipment and procedure proposed for straightening welds if required.

k. Submit Quality Control procedures to be followed.

l. Submit certification documents for individuals conducting the weld testing.

3. Furnish to the Engineer a detailed resume of the facilities, welding procedures, and a list of qualified personnel for approval by the Authority before proceeding with the fabrication of CWR. Include complete details of welding procedures, joint description, joint preparation, upset trimming and grinding procedures, clamping devices, time required, and other data required to fully describe the procedure.

4. Submit to the Authority for approval an order list of CWR with tabulated lengths to be supplied to the project prior to the initiation of shop welding.

L. Continuous Welded Rail (CWR) Track Installation

1. Submit name of independent CWR contractor, a description of their on-track equipment together with procedures and certifications for individuals qualified to perform ultrasonic weld testing in installed track, prior to initiation of testing program.

2. Within 24 hours of completion of CWR Training, submit proof of qualification documentation from the operating railroad indicating the names of the qualified individuals that can serve as the Contractor’s designated on-site Supervisor.

3. Submit certified final ultrasonic rail test results within 10 days of completion of all welds.

4. Submit the proposed “Detailed Work Plan” to the Authority for review within 5 days of completion of walk through as described herein.

5. Submit for approval detailed descriptions of all equipment per Article 3.7, to be used to complete the work. Equipment shall be field inspected by the Engineer upon arriving on-site to determine acceptance.

6. Submit detailed rail installation records, via as-built contract documents, that depict beginning and ending milepost or stationing of newly installed CWR strings and locations of all insulated joints.

7. At the end of each day, submit a complete record of rail string adjustment information to be filled in on the form “Destressing Record Form” included herein as part of Attachment A. The record shall be reviewed and approved by the MBTA Inspector or Resident Engineer on site at the end of each day. The Contractor shall then take a legible picture of the record and send to the MBTA Design and Construction Project Manager, MBTA Railroad Operations, operating railroad designated representative, and the Design Engineer prior to leaving the site daily. Contractor shall formally submit, with a transmittal letter, a .pdf version of the reports for the preceding week to the MBTA by the close of business each Friday.

8. All submittals will be reviewed for general conformance with the intent of the contract documents and upon approval Contractor shall commence work. This review will not relieve the Contractor of final responsibility for the means, methods, procedures, and sequences to be utilized.

9. Submit photograph of the string tag on each new rail string upon installation into the track.

M. Noise and Vibration Mitigation

1. Submit complete details of the ballast mat and appurtenant materials, including Shop Drawings and a detailed procedure for the storage, handling, transport, installation, and protection of the ballast mat (including procedures and equipment to be used for distribution, grading and compaction of initial layer of ballast) to the Engineer for review and approval.

2. Submit sketch plans as described in Article 3.8.A.1 herein.

3. Submit complete details of the ballast mat insertion loss performance qualification tests consistent with procedures described in Article 1.3.R.5 herein or approved best practices for modeling and testing vibration insertion loss.

4. Submit Qualifications of Contractor’s personnel to perform ballast mat installation of comparable scope and complexity.

5. Provide name and qualifications of independent test consultants and/or lab.

6. Manufacturer to provide test results conducted by approved independent consultant and/or test lab verifying that the performance specifications of the ballast mat to be installed under this Contract

are as specified herein and that the ballast mat is compatible with substrates of the track system into which it is proposed to be installed.

N. Electrical Testing

1. Submit testing procedures for track-to-earth electrical resistance tests.

2. Submit name and qualifications of testing agency performing track-to-earth electrical resistance tests.

3. Submit track-to-earth electrical resistance tests results.

O. Calculations

1. Submit manufacturer's calculations showing an analysis of stresses and deformations in the various components of the composite third rail and its effect on its supporting insulators due to extreme temperature rise and fall prevailing on the site and demonstrate that these stresses and deformations are within tolerable limits to the satisfaction of the Authority.

2. Submit manufacturer's calculations showing the distribution of currents between the elements of the composite third rail and how its resistivity is computed. In addition, submit calculations demonstrating short circuit stresses applied on the rail and its supporting members.

P. Work Plan

1. Prepare and submit to the Engineer a general construction procedure to meet the trackwork requirements and tolerances listed herein. The work plan shall, at a minimum, include the following descriptions and sketches:

   a. Construction sequence;

   b. Material handling procedure (outline);

   c. Placement of subballast;

   d. Placement of track ballast;

   e. Placement of ties and OTM;

   f. Third rail installation and erection;

   g. CWR handling and installation; and

   h. Rail anchorage plan.

2. Prepare and submit to the Engineer repair procedures for damaged or non-conforming work.

3. A detailed construction schedule, including hour-by-hour schedules for work requiring outages.

0.3 QUALITY ASSURANCE

A. The Contractor shall perform all measures necessary to assure quality of the Work. This shall include source quality control and field quality control requirements specified in these Specifications.

B. The Contractor shall be experienced in the construction of all types of trackwork included in this Contract, including installation of special trackwork. Such experience shall have been gained on at least three previous contracts of similar volume of work with other North American transit properties and railroads.

C. The Contactor shall implement a comprehensive quality assurance program to assure that the Work is performed as specified in the Contract Documents and adheres to MBTA Section 01400.

D. The Contractor's Quality Assurance program shall be supervised by designated persons qualified to supervise the installation, restoration, and renewal of tracks.

E. General

1. Perform rail inspection and testing and at no additional cost to the Authority.

2. Rail inspection and testing shall be performed by the approved certified independent testing laboratory or laboratories. The Engineer may audit operations at rail mill to ensure that inspections and tests are being performed in accordance with approved procedures and in compliance with these Specifications.

F. The Contractor shall submit the following for approval:

1. A detailed construction schedule, including dates for commencement and completion of all sections of track and special trackwork.

2. A detailed description of the quality assurance program, including the qualifications of all supervisory personnel. Quality assurance program must adhere to MBTA Section 01400.

G. Subballast

1. Provide certified test results of subballast classification, quality and grading as conducted by a testing laboratory. Provide tests for every 1,000 tons of subballast delivered to the job site.

2. If during the subballast installation, the source of subballast changes additional certified test results shall be provided before the subballast is delivered to the site.

3. Certify the subballast delivered is typical of the subballast which has been tested and that has been approved for the Project by the Engineer.

H. Track Ballast

1. Ballast Production Site Testing and Quality Control

a. Contractor shall notify the Engineer, not less than 15 days prior to shipment of any ballast to work site, of proposed source and location of crushed stone ballast. The independent testing

company hired by the Contractor shall obtain samples of proposed material and test them for conformance to classification, quality, and grading requirements specified in Article 2.1.C of this Section. Samples of ballast for testing shall be taken from each 500 tons of prepared ballast. Sample shall be representative and shall weigh not less than 150 pounds.

b. The Contractor will notify the Engineer of test results. Failure of ballast to meet these requirements will mean rejection of ballast quarry.

c. Ballast material will be approved in writing by the Engineer prior to commencing work site delivery.

d. If, during ballast installation, source of ballast changes, the independent testing company hired by the Contractor will perform tests at new production site in accordance with these Specifications. Ballast shall have the same or higher classification, quality, and grading as former ballast used. Work site delivery shall not commence until the Engineer has approved, in writing, the new ballast source.

e. Determinations of deleterious substances, resistance to abrasion and soundness shall be made at the approved testing laboratory, but visual inspection and gradation tests shall be made at the place of production by the Supplier (Quarry) prior to shipment for every 1000 tons delivered.

2. Provide certified test results of track ballast classification, quality, and grading as conducted by testing laboratory for every 1,000 tons of ballast delivered to the job site.

3. Certify the ballast delivered is typical of the ballast which has been tested and that has been approved for the Project by the Engineer.

4. Periodically during progress of track work, the independent testing company hired by the Contractor will test samples of the ballast obtained from in-place locations designated by the Engineer to ensure a uniform quality of ballast. Frequency of in-situ ballast testing will be subject to the discretion of the Engineer and dependent upon site-specific conditions and previous testing results.

5. If ballast in-place does not conform to Article 2.1.C of this Section, the Engineer will notify the Contractor to stop further loading of ballast until fault has been corrected and to dispose of all defective material without cost to the Authority.

6. The Engineer reserves the right to reject any load of ballast arriving at work site for unloading that does not conform to this specification. The load shall be disposed of without cost to the Authority.

I. Timber Ties

1. Acceptance of timber ties will be based upon inspection requirement of the AREMA Manual, Chapter 30, Part 3, and the requirements specified herein. The supplier shall employ an Independent Certified Inspector, acceptable to the Engineer, to perform tests and inspections specified in the AREMA Manual and these specifications.

2. The Engineer or his representative shall have free entry at all times to the facilities to observe the milling, treating, and loading of ties. This observation, if made, will be general in nature and will not alter the fact that acceptance/rejection of the product will be made upon delivery.

3. Tie inspection and testing shall be made at the treating facility prior to shipment. Inspectors will make a close examination of the top, bottom, sides and ends of each tie. Each tie will be judged independently, without regard for the decisions on other ties in the same job.

4. To be accepted ties shall meet the requirements of the AREMA Manual, Chapter 30, Part 3 and these Specifications.

5. Ties will not be accepted until unloaded at the job site and are at supplier's risk until accepted. Material not accepted shall be removed and replaced with acceptable ties at no additional cost to the Authority.

6. Inspection and Treatment of Ties

    a. Inspection

        1) Ties are subject to inspection by the Engineer and/or Owner's Representative at the facility prior to shipment and upon delivery.

        2) Green ties will be inspected at the time of delivery to seasoning area. Dry ties will be subject to inspection after seasoning and before treatment.

        3) Inspector will make a close examination of the top, bottom, sides and ends of each tie. Each tie will be graded independently without regard for the grading of the others in the same lot. Ties covered with ice, or too muddied for ready examination, will be rejected. The responsibility and expense for the inspection described above will be borne by the manufacturer.

        4) Anti-splitting plates that are found to be loose or not firmly against the end of the tie will be cause for rejection of the tie.

        5) All ties to be installed on main line track shall be of Class A condition. No Class B or IG ties will be accepted.

    b. Seasoning

        1) Cross ties shall be air seasoned prior to treatment. Ties shall be stacked for seasoning in accordance with AREMA Manual, Chapter 30, Part 3. Seasoning shall continue for at least 12 months and no more than 18 months.

        2) In the absence of air seasoned cross ties, the Boulton drying process may be used. If the Boulton process is used, conditioning should continue until moisture removal rate indicates a percent moisture retained equal to a 12-month air dried cross tie, but not less than 45 percent by weight.

3) A minimum of 20 borer cores per treatment charge shall be taken of seasoned ties to determine that adequate drying has taken place.

4) The borer cores shall be taken mid-way between the ends and mid-way between the top and bottom surfaces of the tie. Three 3-inch borer cores shall be taken to determined moisture content.

c. Treatment

1) Prior to treatment, anti-splitting plates must be checked by the treating facility to ensure that plates are firmly imbedded in the tie. If plates are found to be loose or not flush against the end of the tie, plate shall be firmly pressed against the tie before treatment begins.

2) Cross tie treatment shall be capable of retention of seven pounds or to refusal of 60/40 creosote coal tar solution per cubic foot of timber in accordance with the AREMA Manual, Specifications for Treatment, Chapter 30, Part 3, Section 3.7.2.1.2, Empty Cell Process.

3) A minimum of 20 borings shall be taken per charge after treatment to determined proper penetration.

J. Steel Rail

1. Perform rail inspection and testing and at no additional cost to the Authority.

2. Rail inspection and testing shall be performed by the approved certified independent testing laboratory or laboratories. The Engineer may audit operations at rail mill to ensure that inspections and tests are being performed in accordance with approved procedures and in compliance with these Specifications.

3. Develop and maintain a quality control program regulating methods, procedures, and processes to ensure compliance with standards of quality required by the Contract Documents.

4. Records of all inspection work shall be kept complete and available during the performance of the Contract.

5. Rail Production Inspection and Testing

a. The products and material incorporated into the work will be subject to inspection, at the place of manufacture, the shipping point, and at the shipping destination. Inspection and tests will be performed in such a manner as not to unduly delay the work.

b. Whether or not there are inspections or tests on materials, the Manufacturer will not be relieved from any responsibility regarding defects or other failures to meet the Contract requirements, nor will such inspection or testing be considered as a guarantee of acceptance of any material which may be delivered later.

c. Rail shall be ultrasonically inspected along its full length for rail flaws.

d. Perform all tests and analyses specified in the AREMA Manual, Chapter 4, Part 2 and submit the results in accordance with this Section.

e. Ultrasonically test all rail for internal defects in accordance with ASTM A578, as modified herein:

1) References to “plate thickness” in ASTM A578 mean rail depth from head to base for measurements from the top of the rail head, or rail web width for measurements laterally through the rail web.

2) Replace “Acceptance Standards” in ASTM A578 by a defect in the occurrence of one of the following readings:

a) Complete loss of back reflection.

b) A reflection from a defect (i.e., not attributable to a reflecting surface of the rail exterior) greater than 5% of the back reflection.

3) Reject a rail if a defect occurs more than 3 feet from either end of the rail.

4) Defects within 3 feet of the rail end may be removed by cropping the rail segment containing the defect if the resulting rail length is to an allowable rail length increment and equal to or greater than the minimum allowable rail length. The reduced rail length will be included as part of the quantity of allowable 10% shorts.

5) Conduct ultrasonic inspection for the full length of each rail with a 1-inch diameter, 45° probe from the top of the rail head, directed along the length of the rail, positioned such that the rail base generates the back reflection.

6) Conduct ultrasonic inspection within 12 inches of each rail end with the 1-inch diameter 45° probe, as in paragraph 5 above, and also with a 1-inch diameter, 0° probe from the top of the rail head, vertically, and through the rail web, laterally. The back reflection for the lateral measurement through the rail web is the web surface opposite the probe side.

7) Conduct ultrasonic inspection by a qualified technician. Provide qualification certification of each individual conducting ultrasonic inspection of the material.

8) Permanently mark all indications on the rail head directly over the defect location with the percentage amplitude relative to the back reflection.

9) Have the manufacturer furnish all the rail inspection results required to complete AREMA Forms 401A through 401C.

f. As an alternative to the requirements of paragraph d. above, ultrasonically test all rails 100% in-line with a fully computerized DAPCO 200 testing unit. Testing shall conform to the requirements of the AREMA specifications. A calibration test rail of the same section as being tested will be utilized with the following calibration reference standard:

1) Head 3/32” wide x 1/2" long slot

2) Web 1/16” wide x 1/2" long slot

3) Base 1/16” wide x 1/2" long slot

g. The contractor shall make all rail tests and inspections at the mill prior to shipment and shall assume full responsibility for all testing indicated. The contractor shall provide sufficient notice when testing in any form is proposed so the tests may be witnessed and provide the free entry at all times to the manufacturer's mill to inspect the processing and testing of rail while work on this Contract is being performed. The contractor shall perform all tests specified herein at no additional cost. Testing must be witnessed and certified by a qualified independent testing firm or individual.

h. In addition to the above, all rails are subject to inspection by the Authority or approved designee, at delivery, for conformance with this specification. The inspection at delivery shall include, but not be limited to, visual inspection and measurements to verify that all rail meets the requirement of this specification.

i. The manufacturer may have a representative present during this inspection.

j. Running rail is at the risk of the manufacturer or supplier until accepted by the Authority. Rails rejected for nonconformance with these Specifications shall be returned to the manufacturer at no additional cost to the Authority.

k. The Authority reserves the right to inspect the rail during manufacture or prior to shipment.

K. Special Trackwork

1. The Contractor shall perform all measures necessary to assure quality of the Work. This shall include source quality control and field quality control requirements specified in these Specifications. The Contractor is encouraged to visit the special trackwork manufacturer to perform facility inspections as part of the quality assurance process.

2. A qualified Independent Testing Agency approved by the Authority shall verify quality control procedures, pre-assembly, and perform all special trackwork inspection and testing. The selected agency shall employ the proper equipment and qualified testing personnel for the special trackwork testing and inspection described in these Specifications. Special trackwork testing and inspection equipment and personnel shall be subject to approval by the Authority. The Authority, or an independent witness designated by The Authority, shall monitor the operations at the special trackwork plant to ensure

that the inspections and tests are being performed in accordance with approved procedures and in compliance with these Specifications.

3. Personnel performing nondestructive testing shall be qualified and certified in accordance with ASNT-TC-1A. Only persons certified for NDT Level I and working under an NDT Level II person or persons certified for NDT Level II may perform nondestructive testing.

4. Testing equipment shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment calibration shall be certified and traceable to national standards such as the National Institute of Standards and Technology.

5. The performance of the independent testing is entirely the responsibility of the Contractor. Any substandard conditions discovered after independent testing and inspection shall be repaired or replaced at no additional cost to the Authority.

6. Turnouts shall be pre-assembled and pre-plated at the manufacturer's facility to ensure proper fit. Following Notice to Proceed, the Contractor shall submit a schedule including the date of delivery and date of factory preassembly for each unit.

7. The Authority or their representatives shall be notified in writing not less than 14 days in advance of dates scheduled for any tests, inspections, or shop assemblies. The Authority or their representatives shall have free entry to the special trackwork manufacturing facilities at all times to inspect material and pre-assembled units and to witness tests. The Authority or their representatives shall be provided with proper facilities and testing equipment to ensure that the special trackwork is as specified. The Authority retains the right to refuse delivery if the work has not been completed in accordance with the Contract Documents.

8. The Contractor guarantees that the special trackwork units and all their component parts shall perform their functions adequately and shall operate successfully without undue wear. The Contractor shall replace and install, at their cost, any part that may malfunction or fail by reason of defective material or workmanship during the following time period: from acceptance of the units at the point of delivery to one calendar year thereafter. Any trips by the Contractor to the MBTA facility, which are necessary for warranty-covered repairs, shall be at the sole expense of the Contractor.

L. Other Track Materials (OTM)

1. Inspection of OTM and any required testing shall be performed at no additional cost to the Authority.

2. OTM inspection and testing shall be performed by the manufacturer or by an approved certified independent testing laboratory. The Engineer may audit operations to ensure that inspections and tests are being performed in accordance with approved procedures and in compliance with these Specifications.

3. The OTM manufacturer shall develop and maintain a quality control program for the entire production process. The quality control program will be subject to audit by the Engineer.

4. Contractor shall further develop and maintain the quality control program to regulate methods, procedures, and processes to ensure compliance with standards of quality required by the Contract Documents.

5. Records of all inspection work shall be kept complete and available during the performance of the Contract; and to such other agencies and for longer periods as may be specified elsewhere in the Contract.

M. Thermite Welders

1. Welding personnel employed by the Contractor shall be certified by the manufacturer of the field weld kits and such certification shall be submitted to the Engineer.

N. Qualifications of Thermite Welding

1. Prepare, in accordance with methods and specifications described herein, not less than three sample thermite welds for each type of rail to be used in the work (heat-treated and control-cooled).

2. Rail Straightness: Check rail for end straightness before welding. Examine both ends and tops of all rails using a 3-foot metal straightedge. Deviations from straight shall be measured with a metal taper gauge. Rails which are at or exceed the tolerances in AREMA Manual, Specifications for Steel Rails, Chapter 4, Part 2, Section 2.1.13.1 shall not be welded.

3. Subject sample welds to laboratory tests as outlined below. Testing laboratory shall be subject to Authority's acceptance and testing shall be at Contractor's expense.

4. Slow Bend Test

a. Test one of the sample welds of each type of rail in accordance with the slow bend test described in AREMA Manual, Chapter 4, Part 3, Sections 3.9 and 3.10.

b. Acceptance criteria: Minimum of one-inch deflection of 100,000 psi modulus of rupture.

5. Hardness Test

a. Test one of the sample welds of each type of rail for Brinell hardness. Prepare sample for testing by longitudinally cross-sectioning and micro-etching.

b. Acceptance criteria: Brinell Hardness Number (BHN) of 310 ± 20 for standard (control cooled) rail and 370 ± 20 for high strength (head-hardened or fully heat-treated) rail.

6. Testing shall be performed by a technician certified to have met ASNT procedure SNT-TC-1A, Level II or III qualifications.

O. Insulated Joints

1. Electrical Resistance Test: Rail joints shall be assembled in accordance with manufacturer's recommendations and supported on non-conducting material. With 500 VDC applied to the rail across the insulated joint for a duration of three minutes, the current flow through the joint should be measured to the nearest 0.01 microampere. The minimum acceptance resistance for the test shall be 10 megaohms. With 50 VAC applied to the rail across the insulated joint for duration of three minutes, the impedance shall be measured with an accuracy of plus or minus 2%. This test shall be repeated three times: once with a frequency in the range from 20 Hz to 100 Hz; again with a frequency in the range from 200 Hz to 1 kHz; and again in the range from 2 kHz to 10 kHz. The minimum acceptable impedance for any of these tests shall be 10,000 ohms.

2. Rolling Load Test: The rail joint used in the Electrical Resistance Test shall be mounted on a 33-inch stroke rolling load test machine supported on 36-inch centers with the joint centered between the supports. Apply a 44,400-pound wheel load on the rail for 2,000,000 cycles and measure and record, to the nearest 0.001-inch, the deflection of the rail at the centerline of the joint. The deflection at the ends of the joint shall also be measured at every 500,000 cycles. The wheel path shall travel from a point 6 inches from the center of the joint to a point 9 inches outside the opposite end of the joint. The total range of deflection of the joint shall not exceed 0.065 inches during the test and the joint shall show no evidence of failure by bending. The electrical resistance test shall then be repeated, and the test results shall be within the acceptance criteria specified.

3. Longitudinal Compression Test: The assembled joint shall be sawn in half where the rails are joined together in a manner which will prevent overheating or damage to the epoxy bond. The cut shall be perpendicular to the centerline of the top of rail. A fixture or device shall be used so that the reaction at the sawn ends occurs only on the face of the joint bars when a load is applied to the centroid of the rail at the opposite end. The load shall be applied in increments of 25,000 pounds, maintaining each load increment until the deflection of the rail stops before increasing the load. The load shall be increased to 650,000 pounds, and a record of loading and differential movement of the rail measure to 0.00 inches shall be measured for each increment. The joint shall show no indication of slippage prior to reaching a compressive load of 650,000 pounds and the movement shall be less than 0.125-inch in any direction. The relative position of the rail and joint bar shall be within 0.031-inch of its original value when the load is removed.

4. The Contractor shall submit certification and test results that an insulated joint has passed the qualification testing specified herein.

P. Third Rail

1. Qualification of the composite third rail manufacturers shall be limited to those manufacturers that have had test sections operating for at least 30 days on the Authority's property or a similar rapid transit application and have performed the accelerated corrosion tests and

other tests elsewhere herein specified to the satisfaction of the Engineer.

2. No. 1 rails shall meet all the requirements of these Specifications and shall be free from injurious defects and flaws of any kind.

3. Rails not to exceed eight percent of the total order, which conform to the following requirements, will be accepted as No. 2 rails:

   a. Rails containing surface imperfections or flaws not more than 1/4 inch deep in the head or 3/8 inch deep in the flange, provided these imperfections or flaws do not occur in sufficient number nor are of a character which, in the judgment of the Engineer, may render the rail unsuitable for use as third rail.

   b. Rails showing an electrical resistance of over six and eighty-five hundredths (6.85), but not exceeding seven times that of pure copper.

   c. All rails after finishing shall be smooth on heads and bases, straight in line and surface, without twists, kinks, waves, or defects of any kind.

Q. Noise and Vibration Mitigation

1. A representative of the manufacturer of the ballast mat shall be present on the Project site(s) at least two days prior to the commencement of ballast mat installation and shall remain on the site(s) to supervise the ballast mat installation work for the duration of the installation or for a period of at least one week, as deemed necessary by the Engineer, to ensure proper installation.

R. Additional Testing

1. Subballast

   a. Provide test result for samples obtained at the quarry for review and approval by the Engineer.

   b. Source materials obtained from the quarry shall be tested in accordance with AREMA Manual, Chapter 1, Part 2, Section 2.11.3.

   c. Materials sampled at the construction site will be tested:

      1) In accordance with AASHTO T191 and ASTM D2922 to determine moisture content and relative density.

      2) In accordance with AREMA Manual, Chapter 1, Part 2, Section 2.11.3 to determine particle size (ASTM D 422) and percent passing No. 200 Sieve (ASTM C 117).

2. OTM

   a. Prior to commencement of OTM deliveries to the project, obtain certified reports from the manufacturers or from an approved independent laboratory indicating the properties as specified.

   b. If the results of any analysis or test do not conform to the specifications, an additional analysis of rest-series of each kind shall be made on a further two samples. Non-conformance or

failure of any of these additional analyses or tests will be cause for rejection of the entire lot.

c. The Engineer or his representatives shall have free entry to OTM manufacturing plants at all times while the work of this contract is being executed, and shall be provided with all proper facilities and testing equipment to ensure that OTM is as specified.

3. Third Rail

a. Perform accelerated and intensified corrosion tests on the proposed composite rail section. Conduct tests in accordance with Authority-accepted test procedures.

b. Perform electrical resistance tests on 39-foot composite rail section. Upon completion of initial test, bend same section to 150-foot radius and repeat test.

c. Perform electrical resistance tests on at least two steel rails from each heat, one from the beginning and one from the end of the heat.

1) The electrical resistance of the steel rail shall not exceed seven (7) times the resistance of pure copper (International Annealed Copper Standard) of equal cross section and at corresponding temperature.

2) The average of these tests taken together with all additional tests that may be considered necessary by the Engineer shall be considered as the resistance of all of the rails of the heat.

d. Joints

1) Test electric resistance of the finished joint, welded or bolted, using a 36-inch gauge length. Apply the gauge so that the joint is at the center or 18-inch point. The maximum resistance measured across a joint shall not be greater than the resistance of 36 inches of rail without a joint. Make the comparison checks of the 36-inch rail on either side of the joint and on both rails as there may be variations of the resistivity of individual rail sections.

2) Make the electrical resistance test using a 100-amp DC current source and a suitable instrumentation arrangement of ammeter and milli-voltmeter. Take simultaneous readings of ammeter and milli-voltmeter. A DC welding generator is a suggested lab standard and shall have been calibrated within the previous six-month period.

3) For welded joints, weld at least one composite joint under conditions similar to those in the field and test in tension with the test results submitted to the Engineer. Submit an additional welded joint to the Authority for testing and approval.

4. Field Testing of Welds

a. Production flash butt welds shall be visually, magnetic particle tested in the field for defects in accordance with Article 1.3.R.4 herein and as per AREMA Manual, Chapter 4, Section 3.10.2.2. Visual testing will be in accordance with AREMA standards. Any rail weld showing surface cracks will be rejected. The attached "Record of Field Welds" form shall be completed for each weld tested.

b. Magnetic particle testing shall be performed in accordance with ASTM E709. Testing shall be conducted with the rail temperature below 800°F. Acceptance Criteria: Particles shall form a regular longitudinal pattern indicating homogeneity of the weld and freedom from defects, surface irregularities, and internal discontinuities.

c. Production thermite welds shall be visually, ultrasonically tested in the field for defects in accordance with Articles 1.3.R.4 herein and as per AREMA Manual, Chapter 4, Section 3.13.4.1. Visual testing will be in accordance with AREMA standards. Any rail weld showing surface cracks will be rejected. The attached "Record of Field Welds" form shall be completed for each weld tested.

d. Ultrasonic Testing

    1) Ultrasonic inspection of welds shall be performed in accordance with ASTM E164 and the recommendations of the Nov. 29, 1983 Proceedings of Association of American Railroads entitled "Railroad Rail Welding" pages 183-205. Prior to testing of welds, the technician certified in accordance with ASNT procedure SNT-TC-1A, Level II or III shall be tested to ensure his ability to detect defects in rail. The test shall be conducted with the calibration rail as specified below serving as the test specimen. The technician shall locate all the holes in the calibration rail by ultrasonic testing. This test will be observed by an independent technician, certified in accordance with ASNT procedure SNT-TC-1A, Level II or III and experience in ultrasonic examination of rail welds. Failure to pass this test will result in the disqualification of the technician.

    2) The following equipment shall be used for ultrasonic testing:

        a) Ultrasonic, pulsed echo, instrument normally used for inspection of rails with calibrated decibel gain control of minimum 2db increments, operating in the range 1-5 MHz, with CRT screen and scale. Equipment shall be capable of detecting a 1/4-inch discontinuity 6-1/2 inches below top of rail.

        b) Calibrated paper tape recording attachments to record accurately the CRT screen indications when a non-complying weld is located.

c) 2.25 MHz angle beam transducers 1/2” x 1” at 70 degrees and 45 degrees.

d) Suitable high viscosity couplets for good wetting characteristics.

e) Standard IIW calibration blocks of carbon steel for primary reference response and to construct distance-amplitude correction curve and DSC Blocks of carbon steel for calibration checks.

f) A “calibration rail”, a piece 136 RE rail, 18 inches long with a 1/4-inch diameter flat bottom hole 6-1/2 inches below top of rail, a similar hole shall be drilled in the center of the head and web and in which other 1/8-inch diameter flat bottom hole patterns have been drilled in the rail base.

3) Incorporate the following in the test procedure:

a) Scanning level shall be +20 db minimum.

b) Scan the rail on one side of the weld only at a rate not exceeding 6 inches per second, so that the full weld is scanned. Each pass will overlap a minimum 10 percent and the scanning is carried out longitudinally to the rail.

c) Calibrate the equipment at the start and end of each day’s work, and at least every four hours during examination, and hourly checks with DSC blocks. If any point on the distance-amplitude curve has been changed by more than 20 percent, all results since the last calibration check shall be void and all welds re-examined. If the curve has moved on the sweep line by more than five percent, all non-complying welds since last calibration check shall be re-examined.

d) When a reflection of greater amplitude than the acceptance criteria is found, scan around the full perimeter of the weld from both sides, to ensure full weld coverage and determination of size, type, and location of discontinuity.

e) Make permanent trace recording of discontinuity indications.

f) Paint the rail web at non-conforming welds on both sides across the weld.

4) All welds shall be free from defect or flaw giving a reflected display of greater than 20 percent of distance-amplitude correction curve at calibration level or will be as listed in Table 1.

TABLE 1

MINIMUM ACCEPTANCE LEVELS

(DECIBELS) WELD THICKNESS (in.)

AND TRANSDUCER ANGLE

REFLECTOR	5/16 to	¾ to 1	1 ½ to 2		2 ½ to 4		4 to	
SEVERITY	70°	70°	70°	45	70	45	70°	45
Large	+8	+3	-1	+4	-4	+1	-7	-2
Small	+9	+4	+1	+6	-2	+3	-5	0
Minor	+10	+5	+3	+8	0	+5	-3	+2

5) Use an ultrasonic test report form that records 20 inspected welds per sheet. The form shall include the location of the weld in track, the results of the ultrasonic inspection including size of defects found in the head, web or base of rail, shape identity and location of all reflections, trace record, the results of the visual inspection, name of inspector, and other information as needed. Welds found defective by ultrasonic, magnetic particle, or visual inspection shall be replaced.

e. Certified test report of the above tests shall be submitted to the Engineer. The Engineer reserves the right to witness these tests.

f. Inspection procedure shall include providing a permanent written record of rails tested and defects detected, showing type and location of each defect.

5. Noise and Vibration Mitigation Qualification Test

a. Ballast mat material shall display minimum required performance characteristics for reducing measured vibration levels when tested (in-situ) for similar track installations and similar rolling stock, as verified by the manufacturer and as specified below:

1) Insertion Loss Performance Requirement:

Measured ballast mat insertion loss will meet or exceed the following one-third octave band values, as measured using test procedures listed below:

1/3 Octave Band Center	Insertion Loss (dB)
50	0
63	3.
80	4.
10	7.
12	8.
16	9.
20	7.
25	0.
31	-0.9

40	0

2) Track Type and Rolling Stock Requirement:

Qualification testing shall be conducted (as directed by the Engineer) on a tangent and at-grade track installation (not on curves, in tunnels, or on bridges). Track type shall be continuously welded rail with wood ties and a 12” minimum track ballast layer. Rolling stock used for test shall include vehicles used during normal passenger service.

3) Qualification Test Requirements, Ballast Mat Insertion Loss:

a) Insertion loss is a measure of the difference in train-induced vibrations with and without the ballast mat installed.

b) Measurements should be made along a stretch of track where the soil conditions are substantially the same for the treated and untreated sections. A minimum of two vibration sensors should be used, one next to the treated section and one next to an adjacent untreated section. In order to minimize flanking from the end of the ballast mat, the sensors should be located approximately 200 feet from the treated/untreated junction (400 feet apart). Vibration data should be recorded simultaneously at the two sites. The sensors should be approximately 25 feet from the track centerline.

c) Vibration spectra should be measured for the same train passing each site, at the same speed. Vibration spectra should be measured in one- third octave bands from 5 Hz to 500 Hz. Vibration spectra should be measured using a “peak-hold” or “band-maximum” type average. Data from multiple passes should be averaged using an energy averaging technique.

d) Train speed should be between 30 mph and 50 mph and should be measured by both the cab recorder and by some other method such as GPS. Multiple train speeds are required. The measurements should be made with rolling stock similar to that used on MBTA transit lines, in particular with a 22-ton per axle load vehicle.

6. Track-to-Earth Electrical Resistance Tests

a. Perform ground contact testing of all completed segments of ballasted trackwork after placement of ballast and prior to conducting track-to-earth electrical resistance tests.

b. As the work proceeds, perform track-to-earth electrical resistance tests at a minimum of one (1) test for every 200-feet of completed track and at special trackwork.

c. Track-to-earth resistance shall be performed in accordance with ASTM G165. Acceptable values of track-to-earth resistance normalized to 1000’ of track (2 rails) are:

1) At grade ballasted track with wood ties – 250 ohms;

d. Undertake corrective measure at locations that do not meet the track-to-earth electrical resistance requirements, as specified. The corrective measures shall extend to the next tested location that meets the specified requirements. Include corrective measures requiring removal and replacement of insulating materials in the track, until the requirements are met. The corrective measures shall be made by the Contractor at no additional cost to the Authority.

e. Re-test the track-to-earth electrical resistance at the corrected locations, as specified.

0.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Subballast

1. Subballast shall be handled, loaded and inspected in accordance with AREMA Manual, Chapter 1, Part 2, Sections 2.5, 2.6, and 2.7.

2. Uniformity of subballast will be a measure of the adequacy of processing, handling, and storage methods. When necessary, to satisfy requirements of type of materials specified, subballast shall be screened, crushed, washed, and otherwise processed with approved equipment that is of adequate capacity and capable of consistently yielding a uniform and acceptable product.

3. Load subballast only into rail cars or trucks which are in good order, tight enough to prevent leakage, waste of material, as well as clean and free from rubbish or any other substance which would foul the subballast material.

4. To be accepted, the stone subballast delivered to the project site shall conform to these Specifications in all respects. Material is at the supplier’s risk until accepted at the specified delivery site by an authorized representative of the MBTA. Material rejected for non-compliance with these Specifications will be returned to the supplier wholly at the supplier’s expense within 48 hours of each rejection.

5. Subballast shall be handled during all stages of shipping, handling, and stockpiling in a manner that will provide a uniform product and will avoid contamination and segregation.

6. Subballast shall be handled and transported at all times with equipment that will avoid undue segregation and contamination by mud or any other deleterious material.

7. Subballast shall not be allowed to fall from a height in a manner that larger particles are thrown beyond smaller particles or that sizes will be separated by wind. Subballast being placed in a bin shall be dropped vertically over center of bin.

8. Do not make repeated passes of equipment over the same level in stockpile area.

9. Stockpiling sites shall be level, well drained, free of all foreign materials, and of adequate bearing capacity to support weight of materials to be placed thereon.

10. Except where stockpiled on concrete foundations or on otherwise acceptably stabilized area, a compacted sand stockpile base not less than 1 foot deep shall be provided to prevent contamination of piled material.

11. Stockpiles shall be built in layers not to exceed 3 feet in depth and each layer shall be completed over entire area of stockpile before beginning the next layer. Subballast delivered to the stockpile in trucks shall be uniformly spot-dumped and stockpile built as specified. Coning of piles or spilling of material over edges of pile will not be permitted.

B. Track Ballast

1. Granular materials used in the production of ballast shall be produced, handled, loaded and inspected in accordance with AREMA Manual, Chapter 1, Part 2, Sections 2.5, 2.6, and 2.7. The Contractor's proposed method of handling track ballast shall be subject to acceptance by the Engineer.

2. Processed ballast shall be handled in such a manner that it is kept clean and free from segregation. It shall be loaded only into rail cars or trucks which are in good order, tight enough to prevent leakage and waste of material, and clean and free from rubbish or any substance which would foul the ballast. The producer should not make repeated passes of his equipment on the same levels in stockpile area. Track ballast containing any substance which would foul or damage the track ballast will be rejected.

3. To be accepted, the track ballast delivered to the project site shall conform to these Specifications in all respects. Material is at the supplier’s risk until accepted at the specified delivery site by an authorized representative of the MBTA. Material rejected for non-compliance with these Specifications will be returned to the supplier wholly at the supplier’s expense within 48 hours of each rejection.

C. Rail

1. Load, unload, and handle rail by approved methods and in accordance with the AREMA Manual to prevent kinking, bending, nicking, or otherwise damaging the rail. In unloading operations, place lengths of rail with the head up, without dropping, and with sufficient support under the base.

2. Rail shall be moved to the approved locations by equipment designed to handle rail, including CWR, without causing damage to the rail. Dragging of welded strings is prohibited.

3. When CWR lengths are pulled along ties or previously constructed track, use approved supporting rollers to support rail above cross ties to prevent damage to rail or tie surfaces.

4. Rail shall be shipped in open railroad flat cars, low-side gondolas or cars specifically manufactured to handle rail.

5. Rail shall be loaded head-up with the rail bases touching.

6. First tier shall be set on blocking with three (3) blocks per 39-foot rail and five (5) blocks per 78- or 80-foot rail. Each subsequent tier shall be blocked in the same manner. Blocking used shall be of sufficient strength to support rail without crushing. Alternatively, load rail into rail roller racks as built onto the rail car of a CWR train.

7. Rails shall be properly banded and secured to the car to prevent movement.

8. During unloading and handling of up to 80 ft length, rail shall be lifted using a minimum of a two-point hitch to avoid causing a horizontal set in the rail.

9. Short rails, when accepted in the order, shall be loaded separately - do not mix full lengths and shorts in the same car, nor when stockpiling.

10. First layer of rail in stockpile shall be on a firm timber foundation to prevent contact with ground and to protect rails from damage.

11. Rails shall be separated in tiers at a minimum of three points per 39 ft. rail or five points per 80 ft. rail. Stock used as separators between tiers of rail shall be oak or other hardwoods that will sustain weight of rails without crushing.

12. For CWR unloading, distribute rail string along the right-of-way or in staging location as approved by the Engineer. Ensure rail is not positioned so as to cause a concentrated load on any part of the rail string. Do not distribute CWR in the gauge of existing track unless approved by the Engineer.

13. Ends of CWR strings shall be offset and blocked to prevent buckling.

14. CWR strings shall not be distributed extending through crossings, side tracks, or bridges without adequate clearance unless otherwise directed by the Engineer. Care shall be taken to not damage existing infrastructure when distributing rail.

    a. When delivering rails to site, be aware of existing track profiles which may be in excess of 2%. Take precautions to ensure that vehicles delivering rails will not slip on rails.

15. Rail rejected because of non-compliance with this specification will be returned at supplier's expense.

16. Bonded insulated joint plug rails shall be protected from damage throughout delivery, storage, and handling. Damage to bonded insulated joint plug rails resulting from improper handling by the Contractor shall require the Contractor to replace all damaged material with new material at no additional cost to the Contract.

17. The leading edge of any bond wire connections or holes of any type shall not be within 6-inches of the centerline of a completed weld of any type, regardless of the order of installation.

18. If present, cut rail a minimum of 9-inches back of a burned hole or a bond wire connection and 1-inch back of a drilled hole. Cut rails square and clean using a rail saw.

19. In the event that conditions warrant deviation from MBTA directives, a design waiver signed by the Chief Engineer and the department owning the scope of work will be required.

20. Note that these requirements exceed the current AREMA requirement of a 4-inch minimum clearance.

D. Timber Ties

1. Handle treated timber and concrete cross ties in a manner to avoid breaking or bruising. Do not throw ties from carts or trucks onto rails or rocks.

2. In placing or spacing timber ties, handle only with tongs or suitable devices. Do not use bars, chisels, forks, mauls, picks, punches, shovels, or sledges for moving ties or placing them in position beneath the rails.

3. Handle and space concrete ties with Authority-approved mechanical equipment.

4. Contractor shall have ties delivered to and stored at construction site. Plan for location and stacking of ties on site will be developed by the Contractor and submitted to the Engineer for review and approval.

5. Storage and/or stockpiling of railroad ties shall be placed on polyethylene plastic sheeting or geotextile fabric in order to impede the migration of tie preservatives to surrounding soil and groundwater. If possible, railroad ties should also be placed on an impermeable surface at the interim location to further prevent potential migration to environmental media. At a minimum, dunnage should be used to prevent direct contact with underlying soils. New ties and/or railroad ties with a strong odor are to be covered with polyethylene plastic sheeting or similar impermeable barrier to prevent olfactory impacts to railroad workers and the surrounding community during storage.

E. Special Trackwork

1. The Contractor is responsible for verifying that special trackwork packages are delivered to the appropriate approved delivery location and that all materials are received undamaged.

2. Carefully handle all rail and special trackwork components to minimize the chance of damage. Rails shall not be dropped or struck sharply. Handle and ship all rail and special trackwork in accordance with AREMA Manual, Chapter 3.

3. The Contractor shall be responsible for transportation from the turnout delivery locations to the installation locations as indicated on the Contract Drawings including all costs and logistical arrangements necessary for completion of the work.

F. Other Track Materials (OTM)

1. Load, unload, and stack OTM in a manner to prevent loss or damage to the materials. Any OTM damaged or lost will be replaced and paid for by the Contractor at no expense to the Project.
2. OTM shall be delivered in approved containers (kegs) or on pallets.
3. Joint Bars shall be wired into pairs, palletized, and strapped for shipment.

0.5 APPLICABLE STANDARDS

A. Pertinent provisions of the following listed standards and publications shall apply to the Work, except as they may be modified herein, and are hereby made part of these Specifications to the extent required.

1. Current American Railway Engineering and Maintenance of Way Association, Manual for Railway Engineering, herein referred to as the AREMA Manual.
2. Current American Railway Engineering and Maintenance of Way Association, Portfolio of Trackwork Plans, herein referred to as the AREMA Portfolio.
3. MBTA Maintenance of Way Division – Book of Standard Trackwork Plans
4. MBTA Standard Specifications, Construction, January 1980
5. Current American Society of Testing and Materials (ASTM) standards, as applicable.
6. Codes and regulations of the jurisdictional authorities.
7. MBTA Maintenance of Way Division – Track Maintenance and Safety Blue, Orange and Red Lines, 2005
8. MBTA Maintenance of Way Division – Light Rail Transit Track Maintenance and Safety Standards, 2008

PART 2 - PRODUCTS

0.1 MATERIALS

A. Herbicide: Type as approved by the Authority.

B. Subballast: Shall be crushed stone or granulated, expanded or air-cooled slag with an average hardness of 5.5 minimum on Moh’s Scale of Hardness. Subballast shall be composed of clean, hard, uncoated particles free from lumps of clay, shale and other objectionable materials.

1. Gradation shall be in accordance with ASTM C136 and C117 as follows:

Sieve Size	Percent Passing by Weight
1 inch	100
3/8 inch	50 to 85
No. 4	35 to 65

No. 10	25 to 50
No. 40	15 to 25
No. 200	4 to 10

The fraction passing the No. 200 sieve shall be less than two-thirds of the fraction passing the No. 40 sieve.

2. Other required characteristics:

   a. Soft Particles – ASTM C235 – 5% of sample weight maximum.

   b. Clay lumps and Friable Particles – ASTM C142 – 0.5% maximum.

   c. Wear ASTM C131 – 20% maximum.

   d. Absorption – ASTM C127 – 0.5% maximum.

3. Existing site material that is suitable for subballast shall be utilized if approved by the Engineer.

4. To satisfy the requirements of this specification, subballast may be screened, crushed, washed or otherwise processed to produce a uniform, acceptable product.

5. Blending of different materials from different sources to improve the quality will not be permitted.

C. Track Ballast

1. Processed (prepared) ballast shall be crushed, quarried and washed stone or a material of comparable characteristic composed of hard, strong, angular and durable particles, free from injurious amounts of substances and conforming to all of the requirements of these specifications.

2. Quality of track ballast shall conform to AREMA Manual, Property Requirements, Chapter 1, Part 2, Section 2.4.

3. Gradation: AREMA size No. 4.

4. Flat or elongated particles having a length equal to or greater than five times the average thickness of the particle shall not exceed five percent by weight of the total when visually inspected.

5. Water absorption shall not exceed 0.4 pounds per cubic foot when tested in accordance with ASTM C127.

6. Percentage of wear, when tested in the Los Angeles abrasion machine in accordance with ASTM C535, grading No. 2, shall not exceed 18 percent.

7. Soundness of the prepared ballast shall be such that when tested in the sodium sulphate soundness test in accordance with ASTM C88, weighted average loss shall not exceed 1.5 percent after 10 cycles of test.

8. Cementing value of the ballast shall not exceed an average value of 320 pounds per square inch for five specimens when tested in accordance with the Logan Walter Page Method (U.S. Department of Agriculture, Bulletin No. 347, 1916, Pg. 15) except as modified as follows:

a. A sufficient amount of pea size pieces of the rock, amounting to about 500 grams (1.1 pounds) is revolved in Los Angeles Abrasion Cylinder with three cast iron balls 4.76 cm. (1.875 inch) diameter and weighting approximately 0.43 kilograms (0.95 pounds) at the rate of 30 and 33 revolutions per minute, and the stiff dough at room temperature resulting from about 500 grams (17.64 oz.) of dust screened through a 100 mesh sieve, mixed with sufficient water, thoroughly kneaded for five minutes, allowed to stand in an air tight container for two hours, is molded into cylindrical briquettes 2.54 cm. (1 inch) diameter by 2.54 cm. (1 inch) in height under a pressure of 132 kgs. Per sq. cm. (1877.5 pounds per square inch), after which they are dried for 20 hours in air at room temperature, 4 hours in a hot air bath at a temperature of 100 degrees C (212 degrees F), then cooled for 20 minutes in a desiccator and immediately tested in a compression testing machine for static crushing strength, the bearing heads being suspended by pivots to secure uniform distribution of load, which is applied at 600 pounds per minute, approximately.

9. Determine ballast weight per cubic foot in accordance with ASTM C29.

10. Ballast samples shall be obtained in accordance with ASTM D75.

D. Timber Ties

1. Wood designated as Group Ta in AREMA Manual, Chapter 30, Part 3, Section 3.5.6.2.1, Table 30-3-1.

2. Dimensions. Unless indicated otherwise, furnish timber ties having the following nominal dimensions:

a. Standard cross ties: seven-inches deep, nine-inches wide, and eight-feet six-inches long as shown in the MBTA Book of Standard Trackwork Plans, Drawing No. 200.

b. Contact-rail ties: seven-inches deep, nine-inches wide, and nine-feet long; except contact-rail anchorage ties shall be nine-feet six-inches long.

c. Switch ties: seven-inches deep, nine-inches wide, length as indicated or required.

d. Short ties: cross section and length as indicated or required.

e. Special length ties: as indicated or required.

f. Include on all timber ties anti-splitting devices conforming to AREMA Manual, Specifications for Devices to Control The Splitting of Wood Ties, Chapter 30, Part 3, Section 3.1.6 and as shown in the MBTA Book of Standard Trackwork Plans, Drawing No. 201.

3. Preservative:

a. Factory treatment: 60/40 creosote-petroleum solution conforming to AREMA Manual, Chapter 30, Part 3, Section 3.6.4.

b. Field application: Copper naphthenate solution conforming to AREMA Manual, Chapter 30, Part 3, Section 3.6.4. Not approved for use on wood that may come into contact with marine waters.

E. Rails

1. Running rail: 115-pound RE Section conforming to AREMA Manual, Specifications for Steel Rails, Chapter 4, Part 2, Section 2.1 and as shown in MBTA Book of Standard Trackwork Plans, Drawing No. 300. Lengths in excess of 39 feet may be acceptable, subject to Authority approval.

   a. Standard (control cooled) rail shall have a minimum Brinell Hardness Number (BHN) of 310 and shall be in conformance with AREMA Manual, Chapter 4, Part 2, Section 2.1.3.2 for Standard Rail.

   b. High strength (head-hardened or fully heat-treated) rail shall have a minimum Brinell Hardness Number (BHN) of 370 and shall be in conformance with AREMA Manual, Chapter 4, Part 2, Section 2.1.3.2 for High Strength Rail.

   c. AREMA Manual, Supplementary Requirements, Chapter 4, Part 2, Section 2.1.17 and Appendix 1, Section 2.1.18 shall also apply.

   d. High strength rail: 115-pound RE Section, Class 2, No. 1.

   e. End holes on all running rails furnished shall be left blank to allow rail to be welded.

2. Guard rail: New or fit relay tee rail approved by the Engineer, and compatible with the dimensions relating to the running rail, as indicated. Guard rail shall be no higher than running rail. Shall be in conformance with AREMA Manual, Chapter 7, Part 2, Section 2.2.5.2 and MBTA Book of Standard Trackwork Plans, Drawing No. 900.

3. Restraining rail: 132-pound RE Section with rail, drillings, and sheared base as shown in MBTA Book of Standard Trackwork Plans, Drawing No. 305. Furnish in 39-foot lengths unless otherwise indicated. Pre-curve rail for radii less than 500 feet.

4. Third Rail: Steel and aluminum composite; steel conforming to standard 85-pound ASCE Section, aluminum conforming to Aluminum Association Specification for Alloy designation EC. The lengths of composite third rail shall be 39 feet, conforming to ASCE with allowable short rail. The Contractor may propose rail lengths up to 60' maximum.

F. Tie Pads

1. Five fabric, or fabric and felt, plies firmly laminated with an adhesive to form a solid unit. Staple with metallic wire to effectively prevent ply slippage during service in track.

2. Completely enveloped in an integral, self-sealing compound to seal the pad to the tie.

3. Tie pads shall be as manufactured Railroad Products Group; Alert Manufacturing and Supply Co.; International Track Systems and Railroad Rubber Products, Inc.; or approved equal.

G. Joint Bars

1. For guard rails; new or fit relay approved by Engineer, having punchings for drillings of the rail sections to be installed.

2. For running rails and special trackwork: new, six-hole toeless joints in accordance with AREMA Manual, Specifications for Quenched Carbon-Steel Joint Bars, Chapter 4, Part 3, Section 3.4 and as shown in MBTA Book of Standard Trackwork Plans, Drawing No. 320, sized to fit 115-pound RE rail.

3. For restraining rails: new, four-hole angle bars manufactured in accordance with AREMA Manual, Specifications for Quenched Carbon-Steel Joint Bars, Chapter 4, Part 3, Section 3.4 and as shown in MBTA Book of Standard Trackwork Plans, Drawing No. 330, with drillings to fit 132-pound RE rail, and sheared as indicated.

4. For rail section transitions: Compromise joint bars shall be used in accordance with MBTA Book of Standard Trackwork Plans, Drawing No. 350 and No. 355 when connecting unwelded rails of different sizes. Transition rails shall be used as necessary to conform to the allowable compromises specified by the Authority. Compromise joint bars shall be new, four-hole or six-hole toeless joints in conformance with AREMA Manual, Specifications for Quenched Carbon-Steel Joint Bars, Chapter 4, Part 3, Section 3.4. Joint bars shall be of a head free design.

H. Bolts, Nuts, and Spring Washers

1. Bolts and nuts shall be new and of proper size for drillings of the rail section to be installed and conforming to AREMA Manual, Specification for Heat-Treated Carbon Steel Track Bolts and Carbon-Steel Nuts, Chapter 4, Part 3, Section 3.5.

2. Spring washers shall be new and of proper size for bolts and nuts to be installed and conforming to AREMA Manual, Specifications for Spring Washers, Chapter 4, Part 3, Section 3.6.

I. Restraining Rail Fasteners

1. Minimum bolt requirements:

a. Bolt length shall be 9 inches.

b. Bolt diameter shall be 1-3/8 inches.

c. Bolts shall meet requirements of any of the following:

1) ASTM F3125 A490.

2) SAE J429 Grade 8.

d. Threads shall be rolled, rather than cut.

e. Finish shall provide resistance to corrosion without compromising requirements stated here-in.

2. Minimum nut requirements:

a. Nuts shall be compatible with selected bolt.

b. Finish shall provide resistance to corrosion without compromising requirements stated here-in.

3. Minimum washer requirements:

a. Plate washers shall be per Book of Standard Trackwork Plans drawing 370.

4. Fastener system shall be capable of applying and maintaining a minimum preload of 70% of the minimum ultimate tensile strength.

5. Once affixed with proper torque, fasteners shall not loosen due to vibrations or spike loads generated by railroad traffic.

6. Installation and maintenance of fastening system shall be capable using conventional tools and equipment.

7. Fastening system shall use a locking mechanism such as Huck 360, or approved equal.

8. Nuts and bolts shall not be reused without prior approval from the Authority.

J. Tie Plates

1. Resilient Fastener Tie Plate

a. New, 115-pound double shoulder canted, 7-3/4 inch by 14-7/8 inch, low carbon steel.

b. Conform to MBTA Book of Standard Trackwork Plans, Drawing No. 225 with 4 outside holes punched as 15/16-inch diameter round holes for use with 7/8-inch diameter screw spikes.

2. Bridge Guard Rail Tie Plate

a. Tie plates for bridge guard rail on ballasted deck bridges shall be new resilient fastener tie plates sized to fit proposed guard rail system, made from low carbon steel and shall conform with AREMA Manual, Chapter 5, Part 1 and with MBTA Book of Standard Trackwork Plans, Drawing No. 905.

b. Tie plates for end of guard rail (the first 5 tie plate sets) shall be pairs of twin hook frog tie plates sized to fit proposed guard rail system, fastened with screw spikes, made from low carbon steel and shall conform with AREMA Manual, Chapter 5, Part 1 and with MBTA Book of Standard Trackwork Plans, Drawing No. 900, Detail at End of Guard Rail.

K. Track Spikes

1. Screw spikes, new, 7/8-inch diameter, 5-3/4 inches under the head, in accordance with MBTA Book of Standard Trackwork Plans, Drawing No. 220.

2. Lock spikes, new, 5/8-inch by 5/8-inch, 7 inches in length, in accordance with MBTA Book of Standard Trackwork Plans, Drawing No. 220.

3. Cut spikes, new, 5/8-inch by 5/8-inch, 6 inches under the head, in conformance with AREMA Manual, Chapter 5, Part 2, Figure 5-2-1 (6” Track Cut Spike).

L. Resilient Fasteners

1. Rail fasteners required for resilient fastener tie plates shall be new and suitable for the size of rail and proposed joint conditions, and shall conform to AREMA Manual, Elastic Clips, Chapter 8, Part 27, Section 27.7.3.2.

2. Rail fasteners shall be based on elastic spring clips which are forged from alloy steel bars and quenched to achieve the spring action holding power specified. Conform to the following criteria:

a. Rail clips shall be of a boltless, threadless, one-piece elastic design which shall permit removal of the rail without the removal of plate holding screw spikes from the timber ties. Two clips shall be provided per each complete rail fastener. Elastic spring clips shall be right hand mounting.

b. Elastic rail clips shall be forged from alloy steel bars, fabricated from spring steel bar stock and quenched to achieve the spring action holding power as specified herein.

c. Field assembly and disassembly shall be possible by both one worker using standard hand track tools and by commercially available equipment.

d. Rail holding force shall be generated by spring action. The minimum vertical hold down force per elastic rail clip fastener shall be 2000 pounds force with 4000 lbf per rail seat. The minimum static longitudinal slip per complete rail fastener assembly with two (2) elastic rail clips in place, shall be 2000 lbf.

e. Rail clips shall be in accordance with MBTA Book of Standard Trackwork Plans, Drawing No. 240.

M. Rail Anchors for Timber Ties

1. Rail anchors shall be new, one-piece, heavy-duty type designed to be fastened to the rail base and to exert rail creepage force against the edge of the tie plate or into the side of the tie.

2. Rail anchors shall be spring type, manufactured from heat-treated steel.

3. Rail anchors shall be Unit V drive-on type by Amsted RPS or approved equal.

N. Insulated Joints

1. Insulated Rail Joints

a. New, poly-insulated joints for 115-pound RE section rail, with high-pressure laminated end posts, two insulated poly-plate tie plates, steel core bushings, fastened with locking bolts.

2. Bonded Insulated Joint Plug Rails

a. Provide bonded insulated joints shop fabricated into 115-pound RE plug rails for installation into CWR. Plug rails shall be 39 feet in length and as shown in MBTA Book of Standard Trackwork Plans, Drawing No. 325.

b. All rail furnished for plug rails shall be head hardened.

c. Fabricate joint bars from quenched carbon steel conforming to AREMA Manual, Chapter 4, Part 3, Section 3.4.

d. Provide 36-inch full-face contact joint bars conforming to the configuration of the rail, as required. Joint bars shall be smooth and straight. The inside face of the joint bars shall have insulating material pre-bonded and shall be smooth with no branding or stamping.

e. Fabrication Tolerances:

1) Finishing Height. Within plus or minus 1/64 inch of the dimension shown on the approved shop drawings.

2) Straightness. All portions of the joint bars adjacent to the rail shall be straight within a tolerance of plus or minus 1/32 inch, measured with a 36-inch straight edge.

3) Length. Within plus or minus 1/8 inch of the dimension shown on the approved shop drawings.

f. Insulating Materials:

1) All insulating materials shall be of high pressure, laminated design, wrapped in Kevlar, impervious to oil, grease and water, and shall have electrical resistance characteristics equal to or greater than fiber insulation meeting the requirements of the AREMA, Signal Manual Part 8.5.3. End posts shall project ¼ inch, plus or minus 1/16 inch below base of rail and shall be 3/8 inch thick.

2) Bonded insulated joint to be cemented together with adhesive and bolted together with six high strength, 1-inch diameter bolts. Provide bolts, nuts and flat washers conforming to the chemical and mechanical requirements of ASTM Designation A490, Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints, and having Class 2A and 2B thread fit. Provide a positive means for maintaining the tension in the bolts through in-service vibrations by a prevailing lock nut complying with Industrial Fastener Institute Standard IFI-100 and IFI-101, or approved equivalent. Locate and size the bolt holes in conformance to the drilling as specified in AREMA Specifications. Flat washers, if required, shall be hardened A-325 or A-490 and tempered carbon steel.

3. Furnish thermite weld kits in lieu of electronic flash-butt welding at locations approved by the Resident Engineer.

4. Furnish and install custom rail fasteners as required by the manufacturer for all insulated joints.

O. Special Trackwork

1. Each special trackwork unit shall be furnished complete with all rails, ties, frogs, plates, fasteners, and all other required material components for a complete special trackwork unit. The Contractor will be responsible for providing all additional materials as necessary to complete the Work.

2. All switches, turnout frogs, center frogs, end frogs, stock rails, closure rails, and running rails within limits of special trackwork items shall be 115-pound RE, high strength steel rail.

3. All frogs shall be rail bound manganese steel conforming to AREMA Portfolio of Trackwork Plans.

4. Closure rails: 115-pound RE Section furnished with blank ends except where the rails are to be connected with joint bars at switch heel assemblies and at frog wings, at which locations rails shall be drilled for installation of 36-inch, six-hole joint bars as shown in AREMA Manual, Chapter 4, Part 3, Section 3.3.

5. Switch timbers, contact rail support ties, and head blocks for switch machines: Sizes and lengths as indicated, conforming to material requirements for timber ties except all timbers for special trackwork shall be field bored.

6. Switch headblock ties: Straight, uniform in size, and free from splits, shakes, and knots; machine dapped in accordance with indicated details prior to the application of wood preservative solution.

7. Joint bars and assemblies: New, 115-pound RE, head-free type with six holes as shown in AREMA Manual, Chapter 4, Part 3, Section 3.3.

8. Track bolts, nuts, and spring washers for bolted joints: New and as specified in AREMA Manual, Chapter 4, Part 3, Sections 3.5 and 3.6.

9. Tie Pads: As specified under Part 2 “Materials” Article of this Specification Section, compatible in size with the tie plates and other plates in the special trackwork items under which the tie pads are to be installed.

10. Frog plates, switch plates, braces, guard rails and other components of the special trackwork items: in accordance with AREMA Portfolio of Trackwork Plans and as indicated.

11. Furnish switch rods with one-hole blank for field drilling to provide 4-3/4 inch throw.

12. Mill straight undercut stock rails equidistant from both ends in accordance with MBTA Book of Standard Trackwork Plans, Drawing No. 845.

13. Rail braces shall be machined for electric switch heaters where indicated on the Contract Drawings.

14. Rail clips shall be of an approved type that permits removal of the rail, switch, or frog without the removal of plate holding screw spikes.

15. The Contractor shall procure switch stands, connecting rods, and targets to accommodate installation of non-powered turnouts as

referenced in the Contract Drawings. Switch stands shall be high-profile with ergonomic handles in conformance with MBTA Book of Standard Trackwork Plans, Drawing No. 930 or approved equal, capable of operating in dual modes. Switch stands shall include appropriate connecting rod with adjustable clevis and shall be furnished with reflectorized green and red target blades.

16. Where required by design, running rail expansion joints shall be sliding (Conley) type; mitered expansion joints shall not be permitted.

P. Third Rail Insulators

1. Insulators to be fastened to wood ties shall be the "Erico" type as manufactured by Erico Products, Cleveland, Ohio or approved equal.

2. Each type of insulator shall meet the physical and electrical properties specified below:

Physical Properties	Requirements
a. Impact, Izod notched, ASTM D256:	6-8 ft. lb./in.
b. Flexural Strength, ASTM D790:	18,000 psi
c. Tensile strength, ASTM D638:	4-8,000 psi
d. Compressive strength, ASTM D695:	20,000 psi
e. Water absorption in 24 hrs. at 23°C., ASTM D570:	0.01 percent
f. Heat Distortion Temperature at 264 psi, ASTM D648:	400°F. (minimum)
g. Flame Retardance, ASTM D229 Ignition time Burning time	 80 seconds 60 seconds
h. Classification	Self-extinguishing
i. U.L. Recognized Reference #E4254:	Yes

Electrical Properties	Requirements
a. Arc Resistance, ASTM D495:	180 seconds minimum
b. Track Resistance, Dust-Fog Ch.:	300 hours minimum
c. Dielectric strength, S.T., perp., VPM, ASTM D149:	300 - 350

3. Teflon Inserts

a. Anti-friction buttons shall be applied to all third rail insulator heads. The buttons shall consist of filled polytetrafluorethylene with the following essential maximum values:

1) Minimum Fatigue Resistance: Sonntag Universal Machine - 20 million cycles at 1,000 psi stress.

2) Deformation under load - min. 2.4 percent per ASTM D621 - 1,000 psi stress.

b. Size O.D. - 0.750 ± 0.001-inch diameter, length 0.250 ± 0.015 inch.

c. Inserts shall be as manufactured by Black & Webster, Inc., 281 Winter Street, Waltham, Massachusetts 02154, or approved equal.

d. All insulators shall be manufactured with four cast-in-place recessed holes across the center line of the insulator head at 90° to the center line of the third rail for placement of the Teflon inserts specified above. The holes shall be 0.1875 (± 0.015) inch in depth and shall be equally spaced across the insulator head to provide a full bearing for the base of the third rail on all four Teflon buttons.

Q. Welding Materials

1. Thermite type rail welds shall be formed utilizing one of the following brands of rail welding kits or an approved equal:

a. Aluminothermic Welding Kit, as manufactured by Pandrol., Napoleon, Ohio.

b. Thermit Self PreHeat - as manufactured by Orgo-Thermit Inc., Manchester, New Jersey.

c. Boutet - as distributed by DuWel Steel Products Company, Chicago, Illinois.

2. The thermite rail welding kits used when welding fully heat treated (or head hardened) rail shall conform to the process manufacturer's recommended standard for such work.

3. The Contractor shall furnish all OTM required to support installation of CWR in conformance to these specification requirements.

4. Installed plug rails shall match section and wear conditions of rail in track, when placing plug rails, or in case of failed welds or gaps in rail after completing thermal adjustments.

5. Provide enough new rail anchors to both replace all the existing anchors removed during thermal adjustment of the rail, as indicated by the limits of work shown on the contract drawings, and enough additional anchors as required for joints that are temporarily bolted.

6. Provide compromise joint, step-down rails, tie-plugging compound and shims as required to install CWR and to ensure proper temporary tie-ins to existing track.

R. Bumping Posts

1. Bumping posts for light rail track shall be in accordance with MBTA Book of Standard Trackwork Plans, Drawing No. 925 and shall be equipped with a cushion head and curved striking face for use with passenger coupler.

2. Bumping posts for heavy rail track shall be in accordance with MBTA Book of Standard Trackwork Plans, Drawing No. 920 and shall be equipped with a cushion head and curved striking face for use with passenger coupler.

S. Superelevation Tags

1. New superelevation tags, to mark the superelevation on curved track, shall be stainless steel 22-gauge, American Iron and Steel Institute Type 302 with unpolished finish No. 4. The tags shall be stamped with embossed gothic figures and fractions as approved by the Engineer.

2. Fluted galvanized nails used to affix the tags to wood ties.

3. Epoxy or construction adhesive used to affix tags to concrete ties, as approved by the Engineer.

T. Noise and Vibration Mitigation

1. Ballast mat material shall satisfy the following requirements:

a. Capacity: Minimum load of 25 tons per axle

b. Maximum Speed: 70 mph

c. Dimensions:

1) Minimum Width: 48" (not including joint overlaps)

2) Maximum Thickness: 2”

d. Temperature Range: Standard quality is suitable for service where ballast mat temperatures range between -4°F and +158°F.

U. Insulating Tie Plate Pads

1. Polyethylene composite with the following properties:
a. Density: X lb/in^3
b. Tensile Strength: X psi
c. Elongation: X%
d. Melting Point: X°F
e. Insulation Resistance: X Ω
f. Hardness: X A

2. Insulating tie plate pads shall extend a minimum of 0.5-inches beyond the ties plate edges on all sides.

V. Insulating Collar Thimbles
1. X

W. Coal Tar Epoxy

1. Two-component, high solids polyamide converted epoxy blended with a refined coal tar pitch.

2. Coal tar epoxy shall be confirmed as chemically compatible with insulating tie plate pad and insulating collar tie materials.

0.2 FABRICATION

A. Rail

1. Fabricate continuous welded running rail in strings not exceeding 1,320 feet in length. Conform to the requirements of AREMA Manual, Specifications for Fabrication of Continuous Welded Rail, Chapter 4, Part 3, Section 3.11.
2. Butt weld rails by approved electric flash methods.
3. Inspect all shop welds by the magnetic particle method. Perform inspections of welds with the dry powder method in accordance with ASTM E109. Cut out with a saw and reweld areas which give fault indication in magnetic particle inspection.
4. Perform sonic tests on five percent of total number of butt welds.
5. Running rails for curves shall be high strength steel rails. Special trackwork shall be high strength steel rails. Conform to the requirements of AREMA Manual, Specifications for Steel Rails, Chapter 4, Part 2, Section 2.1.
6. Bonded insulated joint plug rails shall be installed at the required locations shown on the Contract Drawings.

B. Third Rail

1. Fabricate steel and aluminum composite third rail with hot-rolled steel section mated with aluminum on both sides of the steel section web, as indicated.
2. Either cast the aluminum against the web and secure through drilled holes in the web; or secure aluminum extrusions to both sides of the steel web, at maximum 18 inch intervals with 5/8 inch diameter steel compression fasteners as manufactured by Huck Manufacturing Company of Detroit, Michigan, or approved equal.
3. Provide composite third rail of low electrical resistance, not greater than 0.002 ohm per 1000 feet at 30°C.
4. Clean the web of the steel section of mill scale, foreign matter, grease and oil by subjecting the area where the aluminum contacts the steel to a shot blast method approved by the Engineer.
5. For composite with aluminum extrusions secured by compression fasteners:
    a. Incorporate a wedging or spring-action interface of the aluminum between the fillets of the head and base to ensure a positive electrical connection for current flow between the steel and aluminum. The composite interface shall be maintained under all conditions of thermal expansion and contraction.
    b. After all machining operations, such as drilling, chamfering, and barring, clean the aluminum extrusions by immersing in Oakite

187 or approved equal, followed by a water rinse. Immediately thereafter, coat the contact surface of the extrusion with an oxide inhibiting paste as approved by the Engineer. Protect the interface between the aluminum and the steel web with a compound similar to Dearborn Chemical Product, No-Ox-ID, or approved equal, to prevent corrosion of the steel core.

6. Third Rail End Approach

   a. Fabricate end approaches including joint bars and fastenings as indicated. Fabricate end approaches in accordance with details of the respective assemblies and the material and dimensional requirements indicated.

   b. Third rail end approaches shall have the same steel composition and conform to the electrical characteristics of the 85-pound ASCE rail indicated.

7. Third Rail Anchor

   a. Fabricate third rail anchors to the details indicated.

8. Special Work Sections

   a. Determine from the Contract Drawings and actual field measurements the lengths of the pre-fabricated and field fabricated special work third rail sections required to complete the installation.

   b. It shall be the Contractor's responsibility under the Contract for the proper fit and length of these sections when properly installed.

9. Feeder Cable Terminal Pads

   a. Provide terminal pads for feeder cables from substations or for jumper cables between third rails in quantities as indicated. Design the terminal pads to attach a lug for flexible copper cables or copper braids to the third rail without introducing electro-chemical action or corrosion. Bolt the terminal pads (Huck-Bolted or approved equal) through the web of the third rail, as indicated.

   b. The terminal pad shall permit easy access to the cables for maintenance purposes or for detaching or reconnecting the cables, as approved by the Engineer.

   c. The terminal pad shall carry a continuous direct current (DC) of 2,000 amperes. Each terminal pad shall be of sufficient size to accept a maximum of two, standard NEMA, two-bolt 1,000 MCM copper cable lugs, as approved by the Engineer.

C. Timber Ties

1. Timber ties shall be manufactured in accordance with AREMA Manual, Specifications for Timber Cross Ties, Chapter 30, Part 3, Section 3.1.

2. Size acceptance: Per AREMA Manual, Chapter 30, Part 3, Section 3.1.1.3.

3. Boring: Per AREMA Manual, Chapter 30, Part 3, Section 3.1.4.3 and as detailed on the Contract Drawings.

4. Tie Plugs: Per AREMA Manual, Chapter 30, Part 3, Section 3.1.5.

5. Anti-splitting devices: Per AREMA Manual, Chapter 30, Part 3, Sections 3.1.6 and 3.1.7, as specified therein for steel strip irons.

6. Preservative Treatment. Treat timber ties in accordance with AREMA Manual, Chapter 30, Part 3, Section 3.7.2 as applicable to the preservative specified in Article 2.1.D.3.

PART 3 - EXECUTION

0.1 GENERAL

A. Track construction shall be performed as shown on the contract plans. Construction within existing right of way shall be coordinated with the Operating Railroad and shall be performed in a manner that will minimize impact to railroad service. Flagging and inspection services, as required by the Operating Railroad shall be arranged for by the Contractor and at the expense of the Authority.

B. Alignment information shown on the Contract Drawings refers to geometric control points used for the design and construction of track. Alignment data for each track is included in the Contract Drawings.

0.2 SUBGRADE PREPARATION

A. Prior to commencement of trackwork construction, the Engineer will determine the existing condition of the trackbed as to line, grade, cross section, and compaction.

B. If the subgrade does not conform to the indicated details and requirements of Section 02300 - EARTHWORK, the Engineer will direct the Contractor to refinish the subgrade accordingly.

0.3 HERBICIDE

A. Before placing track ballast, spray an approved pre-emergence herbicide over the entire surface of the trackbed and to the edge of the trackbed shoulders.

B. In yards, spray the herbicide on all areas to be covered with track ballast and all track foot paths.

C. If weeds more than one-inch high are showing on the subgrade, the Engineer may require an approved contact herbicide to be added to the herbicide.

D. Application

1. Apply herbicide in accordance with manufacturer's instructions to the trackbed after final shaping has been completed.

2. Confine the application to the particular area to be treated, avoiding contact with lawns, shrubs, crops, or other desirable plants not intended to be destroyed.

3. Do not spray when wind velocity is greater than three miles per hour unless otherwise permitted by the Engineer.

0.4 PLACEMENT OF SUBBALLAST

A. Material shall not be placed on subgrade that is muddy, rutted, snow covered, or frozen.

B. Prior to placement of subballast all trash and debris shall be removed from subgrade. Subgrade shall be clear and void of tire ruts, large stone or other deleterious objects before placement of subballast. Subgrade shall be freely drained and compacted to the required density before placement of subballast.

C. Apply subballast course over the prepared subgrade or subbase and compact.

1. Before placement of subballast, subgrade shall be proof-rolled using heavily loaded pneumatic-tired equipment or, by vibratory roller on granular subgrades.

2. Where soft places are located they shall be undercut to a suitable depth, no less than 6 inches, and backfilled with granular aggregate as directed by the Engineer.

D. Deliver aggregate for subballast as uniform mixture and spread in layers without segregation.

E. Place subballast material with sufficient moisture to allow compaction to specified maximum density.

F. Compaction shall be accomplished with one or more of the following:

1. Pneumatic-Tire Roller. Pneumatic-tire rollers shall be of the self-propelled type consisting of two axles equipped with pneumatic tires mounted so as to completely cover the area to be compacted in a single pass. The wheels on at least one axle shall oscillate vertically, either singly or in pairs. The roller shall have a width of not less than 5 feet. Wobble-wheel rollers will not be permitted. The wheels shall be equipped with smooth, wide-tread compactor tires of equal size and diameter, capable of producing a uniform, ground-contact pressure on a level, unyielding surface through a range of 60 to 95 pounds per square inch on all wheels. Operating tire contact pressure shall be maintained by the use of ballast, and tire inflation pressure combinations shall not exceed the recommendations of the Tire and Rim Association Incorporated for the applicable tire size and ply rating.

a. All tires shall be uniformly inflated so that their respective tire pressures do not vary more than 5 pounds. Charts and tabulations shall be furnished showing the contact areas and contact pressures for the full range of tire inflation pressures and for the full range of loadings for the tires used.

2. Dynamic Compactor. The compactor shall be a vibratory roller or vibratory pad- type compactor capable of operating at the optimum frequency of vibration required for the size and type of compactor used and for the type of material being compacted. Vibratory pad-type compactors shall be used only when access with a vibratory roller is not practical. Vibratory rollers shall be equipped with a readily visible instruction plate containing the manufacturer's recommended operating frequency, amplitude and roller speed. A calibrated vibrating reed tachometer shall be provided with each roller to permit a mechanical check of the roller vibration control system.

G. Subballast course shall be minimum uniform thickness, after compaction, of dimensions indicated on the contract drawings. Where not indicated, compacted thickness shall be a minimum of 8 inches.

H. Compaction of each layer shall continue until the material meets 95% dry density compaction. The in-place dry density of each compacted layer will be determined in accordance with AASHTO T 191.

I. Thickness of finished subballast course shall not vary more than 1 inch from the indicated thickness at any point. Reshape or rework, water, and recompact subballast to achieve compliance with specified requirements which do not conform to this requirement.

J. The surface of the finished subballast course at any point shall not vary more than +1” above or 0” below the indicated grade.

K. The Contractor shall obtain a test lab approved by the Engineer to perform tests in accordance with AASHTO T 191 and ASTM D2922 to determine compliance with specified requirements for density and compaction of subballast, and with ASTM D3017 to determine moisture content of the installed subballast.

0.5 BALLAST PLACEMENT

A. Ballast shall be placed at a minimum ambient temperature of 35°F.

B. Prior to placement of base layer of ballast, all trash and debris shall be removed from subballast. Subballast shall be graded to be clear of voids and ruts and shall be fully compacted.

C. Place and compact stone ballast on the prepared subgrade in two layers not exceeding five inches each, compacted, with the final layer of compacted ballast not less than two inches below the final grade of the bottom of the ties before track construction operations commence.

D. Deliver ballast at a rate no faster than can be satisfactorily incorporated into the work, maintaining a proper interval of operations and at such times as to permit proper inspection by the Engineer.

E. To the extent practical, unload ballast in a position of use with a minimum of redistribution and dressing.

F. Self-spreading vehicles of Authority-approved type may be used. When stone is initially spread by self-spreading vehicle, a power grader of Authority-approved type may be used to assist the spreading operations. If

results of spreading with the power grader are found unsatisfactory, permission for use of the grader will be withdrawn.

G. Shape stone ballast to a true section conforming to the ballast section shown on the Contract Drawings. Thoroughly compact until the stones are firmly interlocked and the surface is true and unyielding.

H. Compact with rollers or with vibratory compactors subject to the following:

1. Each lift of ballast within the base layer shall be uniformly spread and compacted (tamped) with not less than four passes by either a self-propelled, pneumatic-tired roller or vibratory compactor.

2. Compact by rolling using either an approved self-propelled, three-wheel, two-axle roller of such weight that will provide compression under the rear wheels of not less than 350 pounds per linear inch of tread; or using an approved two or three-wheel tandem roller having a weight per inch of drive roll of not less than 350 pounds, and with every part of the surface receiving compression from the drive wheels.

3. Compact by vibration using vibration compactors of either the roller or pad type. Dynamic force for either type shall be not less than 20,000 pounds and the frequency range shall be 1100 to 1500 vpm. Use machines equipped with a governor which can be set and locked to control the rate of impulse as required by the Engineer. Provide a tachometer or other suitable device for accurately checking the frequency of vibration during the compacting operation.

0.6 INSTALLATION OF TRACK

A. General

1. Conform to requirements of AREMA Manual, Specifications For Track Construction, Chapter 5, Part 4, including Appendix 1, as modified herein.

2. A corrosion resistant lubricant shall be applied to bolts and joint bars.

3. Rail bonds shall be installed on standard bolted rail joints according to bond manufacturer’s instructions. The maximum electrical resistance of each installed rail bond shall be 85 micro-ohms.

B. Tie Placement

1. The top surface of the base layer of ballast shall be smooth, flat, and uniformly compacted prior to distributing ties.

2. Space cross ties and contact rail support ties as indicated on the Contract Drawings.

3. Respacing of ties to avoid conflict with power ducts, manholes, and drainage facilities will be as determined in the field by the Contractor and approved by the Engineer.

4. Place timber ties so that the heartwood is down.

5. Place ties normal (perpendicular) to centerline of track unless shown otherwise on the Contract Drawings.

6. Spike timber ties according to patterns indicated.

7. Prior to installation of tie plates, clean contact surfaces to allow proper bearing of the tie plate on the tie and the rail on the tie plate.

8. Do not field cut timber cross ties, third rail support ties, or switch ties without permission of the Engineer. Treat all surfaces so cut or adzed with a preservative as specified in Article 2.1.D.3.

9. Place insulating tie plate pads between the tie plates and the tie in accordance with the recommendations of the manufacturer.

10. Timber cross ties shall have tie plates installed under each rail as follows:

    a. Locate tie plates on longitudinal centerline of each tie and place square to centerline of rail so that outside shoulder of plate bears fully against the rail base. Place plate with the downward rail cant toward center of track.

    b. Secure rail on line end of ties to tie, in proper relation to the tie end, before securing opposite rail.

    c. Use line rail as reference in securing opposite rail to proper gauge.

11. Tie Boring

    a. Field bore cross ties and switch timbers before fastening the plates.

    b. Holes in cross ties shall be 5/8-inch diameter and 5 inches deep for screw spikes.

    c. Location and number of holes shall conform to location and number of screw spikes. Boring of holes in excess of number required will not be permitted.

    d. Do not bore holes entirely through tie.

    e. After drilling, brush drill chips from top surface of tie.

    f. Immediately treat bored hole with approved coal tar epoxy.

    g. Prior to locating position of holes to be bored for second rail, position tie laterally so the field side base of the first rail is in contact with the shoulder of the plate. Any tolerance between rail base width and plate seat width shall be on gauge side of rail. Position other plate similarly to ensure retention of established gauge.

12. Screw Spikes

    a. Start and drive screw spikes vertically and square with rail. Drive spikes straight.

    b. Straightening screw spikes will not be permitted. Screw spikes bent during driving shall be withdrawn and a replacement spike driven.

    c. Number of screw spikes used per tie shall conform to the Contract Drawings, and MBTA and AREMA standards.

d. Under no circumstances shall gauge be adjusted by striking spikes or plate edge after it is fixed to tie.

e. Seat rail properly between tie plate shoulders with outside base of rail tight against outside plate shoulder.

13. Remove ties damaged as a result of improper handling by the Contractor and rejected by the Engineer and replace with undamaged ties at no additional cost to the Authority.

C. Rail Placement

1. The ends of CWR rail strings shall be fabricated with two holes, drilled at the second and third hole location (2 holes furthest away from rail end) for a 6-hole joint bar in conformance with MBTA Book of Standard Trackwork Plans, Drawing No. 300.

2. Transport and distribute rail in such a manner and by use of such equipment that bumping or striking of the rail shall be avoided. Transport and lay CWR in place in an efficient, expeditious manner that shall prevent damage to the ties and rail. Do not drop rail on track bed.

3. Place welded rail on the tie seat.

4. Lay CWR strings with ends spaced as required by the welding method proposed to accommodate the field weld as specified in Article 3.7.

5. Anchor CWR rail strings at rail temperature as specified in Article 3.7.A.2. Postpone anchoring of the strings until rail temperature, either by regulated methods or by normal daily temperature range, is within the specified range. Artificial heating methods proposed for cold weather anchorage shall be subject to approval by the Engineer.

6. Use a standard rail thermometer to ascertain the temperature of the rail. Lay the thermometer close to the web side of the rail base which is shaded from the sun. Maintain the thermometer so placed for a sufficient time to accurately record the rail temperature.

7. Provide complete and current record of all field welds; show the following for each weld:

a. Location by station, track designation and rail;

b. Date and time;

c. Rail weight and section, mill brand, year rolled, heat number, and type of rail (i.e., heat-treated or control-cooled);

d. Name of manufacturer of field weld kit used;

e. Air temperature, rail temperature, and approximate weather conditions;

f. Rail gap to nearest 1/16 inch;

g. Track alignment and construction (curve, tangent, grade, etc.);

h. Name of Engineer or authorized representative present;

i. Name of Contractor's foreman present;

j. Name of manufacturer's representative.

D. Field Welding

1. Ambient temperature during installation shall not be less than 35°F.
2. Use thermite welds to connect CWR strings as approved by the Engineer, and for closure welds joining new and existing rails, in conformance with AREMA Manual, Specification for Quality Assurance of Thermite Welding of Rail, Chapter 4, Part 3, Section 3.13 and as specified herein.
3. Restrict cuts in CWR to achieve a minimum practical number of thermite welds.
4. Saw-cut or grind rail ends in conformance with Article 3.7.B.5.d.
5. Torch or flame cutting of rail will not be permitted.
6. Make field welds in accordance with the Authority-accepted welding procedure described under Submittals. Field welds shall have full penetration and complete fusion with no visible evidence of fissures or cracks. The total area of internal defects shall not exceed 0.060 square inch and the longest single defect shall not exceed 0.125 inch in any dimension.
7. Trim and grind the weld in conformance with Article 3.7.B.5.j.
8. Eliminate notches in conformance with Article 3.7.B.5.j.
9. Remove all fins on the weld due to grinding drag.
10. Furnish templates and feeler gauges to the Engineer for checking purposes.
11. Perform heavy grinding on the hot metal immediately following welding to reduce metallurgical damage.
12. When connecting newly adjusted CWR to existing rail sections, Contractor shall solid box anchor from the end of the CWR, through the transition rail, and to a distance of at least 200 feet from end of existing rail.
13. Joints and welds shall be offset a minimum of 5’ longitudinally from each other.

E. Rail Anchorage

1. Install rail anchors in accordance with manufacturer's instructions and to patterns indicated.
2. Apply rail anchors for timber tie construction immediately behind the laying of rail except when necessary to adjust lengths of CWR due to temperature at time of laying. Apply anchors in such cases immediately following temperature adjustment as described under Article 3.7.
3. Avoid removal of spikes once driven. When necessary, remove spikes and plug the holes with tie plugs as described in Part 2.2.C.4 of this Specification Section to completely and tightly fill the hole. Install new tie pad.
4. Anchorage for CWR on concrete ties shall be accomplished by tightening the running rail fastening bolts in accordance with the

manufacturer's recommended torque at the specified temperatures after field welding.

5. Following anchorage and connection of welded rail, and on the same day that anchorage is applied with rail at specified temperatures, unload and place sufficient ballast to restrain track movement.

F. Surfacing and Alignment Track

1. Ballasting

a. Following assembly of track, unload ballast in tie cribs and shoulders of track structure.

b. Unload ballast in quantities which will fill tie cribs and provide an adequate amount of ballast for the initial track raise with sufficient surplus to continue to hold track after initial raise.

c. Prior to dumping ballast in track, ties shall be properly spaced as specified and shall be square with rails.

d. Contractor shall re-space and straighten ties as required before stone is distributed.

e. The Contractor shall use a ballast regulator machine to distribute the stone ballast in sufficient quantity for tamping the track and for restoring the ballast section.

f. The Contractor shall avoid pulling vegetation and other foreign material onto the track structure or shoulders for purpose of tamping or dressing the ballast section. Any vegetation or foreign matter inadvertently pulled in shall be removed by the Contractor prior to tamping.

g. Clean the track way area of all debris and standing water prior to placing of ballast. Do not place ballast on frozen subgrade or subballast.

h. Deliver ballast at a rate no faster than can be satisfactorily incorporated into the work.

i. To the extent practicable, unload ballast in position for use with a minimum of redistribution and dressing.

2. Tamping

a. Tamp ballast with 16-tool, squeeze-vibratory type, production-style, power tamper equipped with a laser liner. Control of power tamper shall ensure maximum compaction of ballast uniformly along track. The Engineer will determine tamping variables, including rate of advance, number of passes, number of insertions per tie (if more than two are required), length and number of blades, and frequency of vibration. Tamping tools shall be replaced when the working surface is worn more than 30 percent of its original surface area. Procedures and equipment shall be as approved. To allow for proper insertion depth below bottom of cross ties, the tamping tools shall be adjusted to compensate for concrete/timber cross tie size difference and where rail size changes.

b. Tamp ballast thoroughly under both sides of tie from a point 15 inches inside rails to ends of tie.

c. For each tie, tamp simultaneously inside and outside both running rails on both sides of tie. Minimum tamping insertions will be two per tie, per pass of tamper.

d. Tamping on snow covered or frozen ballast will not be permitted.

3. Initial Surfacing and Aligning

a. Surface and align track and turnouts to achieve horizontal and vertical alignment as specified.

b. Initial surfacing and aligning shall be performed to bring track geometry to within one inch of final profile and to within one inch of final alignment, prior to thermal adjustment of rail.

c. Surface and align track by methods which will prevent undue bending or kinking of rail, straining of joints, or damaging of rail fastening assemblies.

d. Surface and align track only after cribs are filled with ballast.

e. The amount of any track lift shall neither exceed three inches nor endanger horizontal and vertical stability of tracks.

f. Perform as many raising and surfacing passes of three inches or less as needed to bring track surface to within one inch of final design elevation as shown on Contract Drawings.

g. Restore ties pulled loose during surfacing to full bearing against rail and properly secure them.

h. Remove and replace with new ties and fasteners any ties or fasteners damaged during surfacing operations at no additional expense to the Authority.

i. The gauge of the tracks shall be as indicated and shall be measured between points on the inside face of the running rails, 5/8 inch below the top of rail on heavy rail track and 1/2 inch below top of rail on light rail track.

j. The grade rail on all curves shall be the inside rail of the curve.

4. Final Surfacing and Aligning

a. Final surfacing and aligning of track and turnouts shall be completed after track has been initially surfaced and aligned, thermally adjusted, clipped and field welded.

b. Final surfacing and aligning shall be required to bring the track and turnouts to final grade and alignment and to comply with surface and superelevation tolerances specified and shall consist of a lift of one inch maximum unless otherwise directed by the Engineer.

c. Thoroughly tamp after raising.

d. Provide a minimum of 12 inches of compacted ballast under timber and concrete ties at final alignment.

e. Maintain an adequate ballast section at all times to ensure proper track restraint.

f. Final surfacing and aligning shall be performed on all track and turnouts within project limits.

g. During final track raise, line track to final alignment. Track liner employed shall be a fully automatic model capable of determining existing curve data, computing new values for optimum curve value, and lining track to the new values without disturbing track surface. Machine shall be capable of producing a tape or graph showing existing and proposed values and this tape shall be reviewed and approved by the Engineer prior to final lining. Tape shall become the property of the Authority.

h. Shimming of track between rail tie and tie plate in order to achieve proper vertical alignment shall not be permitted.

5. Ballast Consolidation and Ballast Dressing

a. Concurrent with both initial and final surfacing and aligning of all tracks and turnouts, consolidate cribs and shoulders and dress ballast to conform to ballast section shown on Contract Drawings.

b. Where the following activities are performed, final consolidation of the ballast shall be by means of a dynamic track stabilizer in order to lock ballast particles into place and adjust any imperfections in cross-level:
   1) Full or partial depth track construction/reconstruction.
   2) Out of face (>200 feet) surfacing and aligning
   3) Out of face (>200 feet) undercutting
   4) Out of face (> 6 ties per 39 feet) tie renewal

c. After final surfacing and alignment of track is completed, consolidate cribs and shoulders and dress ballast to conform to ballast section shown on Standard Plans and Contract Drawings. Top of ballast shall be one inch below base of rail.

d. Regulate and dress ballast as indicated in cross sections on the plans with a ballast regulator and by hand as required. Leave that portion of the subballast or subgrade outside of the ballast with an even surface which has been sloped to drain away from the tracks.

e. Upon completion of final surfacing and aligning, produce as-built chart from tamper or liner and submit to the Engineer.

6. Superelevation Tags

a. Use superelevation tags as specified in Article 2.1.S to mark the zero beginning and full elevation points of superelevation and to mark 1/4-inch increments of elevation between zero and full points of superelevation.

b. Attach tags stamped with superelevation in 1/4-inch increments from zero superelevation to maximum superelevation for each

curve to ties at points approximately one foot inside base of high rail. All numerals shall be 1/2-inch in height.

c. Place tag with numbers parallel to length of tie to be read when facing in direction of increasing elevation, except place tag which indicates full elevation parallel with rail to be read from track centerline when facing high rail.

d. Attach tag to tie using 2 nails per tag on timber ties.

G. Track Geometry

1. Construct track to conform with the alignment, profile, and cross-sectional data as indicated on the Contract Drawings.

2. For tangent track, the alignment is based on each centerline of track, equidistant between the gage faces of the running rails.

3. For curved track, the alignment is based on the centerline of track with the outside rail located 2 feet 4-1/4 inches radially from the centerline measured at the gage face of the rails.

4. Track gage as specified herein:

a. Track gage shall be 4 feet 8-1/2 inches for tangent track and any curve with a radius exceeding or equal to 1000 feet.

b. Track gage shall be 4 feet 8-7/8 inches for track with a radius between 1000 feet and 125 feet.

c. Track gage shall be 4 feet 8-3/4 inches for track with a radius less than 125 feet.

5. Rail Cant (Inclination)

a. Ballasted track shall be constructed with a 40:1 inward rail cant (inclination) of the rails.

b. Rail in special trackwork shall be constructed with no rail cant.

6. Track Cant (Superelevation):

a. Superelevate curved track as indicated on the Contract Drawings. Tangent track shall not be superelevated, except as provided in the Contract Drawings.

b. Superelevate the outer rail above the inner rail; the low rail shall be at the required profile grade line indicated on the Contract Drawings.

c. The superelevation at the tangent-to-spiral point (TS) shall be zero and shall increase uniformly through the length of the spiral to full elevation of the outer rail at the spiral-to-curve point (SC).

d. Turnouts and crossovers shall not be superelevated, unless specifically noted on the plans.

e. Prior to final surfacing, tags attached to the ties as specified in Article 3.6.F.6 shall be used to mark the beginning and ending points of superelevation.

7. Track Surface:

a. Track surface is the relationship of both rails opposite each other in profile and cross level.

b. Track profile is the running surface along the top of the rails or grade rail.

c. Cross level is the difference in elevation between the top of heads of opposite rails measured at right angles to the track alignment.

H. Track Tolerances

The final gauge, cross level, and horizontal and vertical alignment of main track shall be within the tolerances shown below. Tolerance limits from true line, grade, and gauge shall be made with smooth transitions of adequate lengths. This required level of track geometry shall exist at the time of inspection for the acceptance of work.

1. Main Line

Gauge variation	± 1/16-inch
Cross Level:	
Variation from design at any point	± 1/16-inch
Rate of change of permissible variation from design shall not exceed	± 3/16-inch in 31 feet
Horizontal Track Alignment:	
Maximum permissible variation from design shall not exceed	± 1/4-inch
Rate of change of permissible variation shall not exceed	± 3/16-inch middle ordinate in 31-foot chord on curves, and ± 1/16-inch in a 31-foot chord on tangent
Vertical Track Profile:	
Maximum permissible variation from design shall not exceed	± 1/4-inch
Rate of change of permissible variation from design shall not exceed	± 1/16-inch middle ordinate of a 31-foot chord

2. Yard Tracks

Gauge Variation	± 1/8-inch
Cross Level:	

Variation from design at any point	± 1/8-inch
Rate of change of permissible variation from design shall not exceed	± 3/16-inch in 31 feet
Horizontal Track Alignment:	
Maximum permissible variation from design shall not exceed	± 1/2-inch
Rate of change of permissible variation shall not exceed	± 1/4-inch middle ordinate in 31-foot chord on curves, and ± 1/8-inch in a 31-foot chord on tangent
Vertical Track Profile:	
Maximum permissible variation from design shall not exceed	± 1/2-inch
Rate of change of permissible variation from design shall not exceed	± 1/8-inch middle ordinate of a 31-foot chord

3. Upon completion of the track construction in accordance with the specified tolerances, shape and dress the ballast section as indicated.

4. Inspection Devices. Furnish to the Engineer the following items for the Engineer's use in inspecting trackwork:

   a. Four track thermometers, as manufactured by Quaker Railroad Equipment Corp., or approved equal.

   b. Two track gauges, as manufactured by Woodings Verona, or approved equal.

   c. Two Roadmaster track gauges, as manufactured by Woodings Verona, or approved equal.

   d. Two straight edges, 36-inch metal, as manufactured by Starrett, or approved equal.

   e. Four taper gauges, as manufactured by Starrett, or approved equal.

   f. Two string line paddle kits, as manufactured by Quaker Railroad Equipment Corp., or approved equal.

   g. Two wooden ballast templates fabricated to indicated dimensions for checking completed ballast section.

5. Final Track Inspections

   a. Final horizontal and vertical alignment, gauge, superelevation and cross level shall be within the tolerances specified. In order to determine the acceptability of finished track, the Contractor

together with the Authority shall conduct a final inspection to establish that track construction is within tolerances specified herein.

b. Track deviations disclosed by inspection, which exceed tolerances specified herein, shall be corrected by the Contractor at no additional cost to the Authority. Re-inspections shall be made by the Contractor and Authority to ensure that corrections have been made.

c. Final inspection will include testing by an approved Contractor-furnished track geometry test car capable of testing gauge, cross level, left and right rail profiles, track alignment, twist, warp and superelevation. Test car shall be capable of measuring the parameters specified above with sufficient accuracy, at 1-foot increments, to establish that the track construction is within the specified tolerances.

d. Notify the Engineer one month in advance regarding the request for the scheduling of final track inspections.

e. The Contractor shall correct track deviations, as disclosed by final inspection, at no additional cost to the Authority.

f. The Contractor shall participate in any retesting, required as a result of corrections to work, at no additional cost to the Authority.

I. Special Items

1. Insulated Joints

a. Insulated Rail Joints

1) Install insulated joints at locations in the track designated by the Engineer. Center end posts for insulated joints between two adjacent ties upon which are insulated tie plates. Before joints are applied, clean the parts of the rails to be covered by the insulated joint to remove all rust, scale and dirt, and clean metal parts of the joint.

2) After cutting the rail at the insulated joint location, first apply the end post and joint bars to each side of the rails, then insert the insulating bushings in the bolt holes, and apply the metal washer plates with the bolts and nuts.

3) Cut rails square and clean at right angles to the rail by means of rail saws or abrasive cutting wheels to provide uniform width of gap between rail ends.

4) Accurately space and drill holes for bolting of rails by an approved type rail drill. Drill cylindrical holes of proper diameter for the size of bolt required directly through the web of the rail. Use an approved template for a guide for drilling holes. In no case shall a joint bar be used for this purpose.

5) Cutting rail or burning holes in rail by means of a heat dependent device is prohibited.

b. Bonded Insulated Joint Plug Rails

1) The Contractor shall install bonded insulated joint plug rails at the required locations as shown on the Contract Drawings.

2) Bonded insulated joints shall be installed as suspended joints and existing cross ties shall be re-spaced as necessary to achieve this requirement. When crossties are unable to be re-spaced a polyurethane tie plate shall be used and insulated joint secured with modified “e” clips.

3) Joints created by installation of the insulated joint plug rails shall be field welded by an approved thermite process.

4) Rail removed for the installation of the insulated joint plug rails shall be salvaged as specified in this Section.

c. Removal of existing insulated joints

1) The Contractor shall remove existing insulated joint plug rails and install standard rail at required locations.

2) Removal of an existing insulated joint plug rail shall be accomplished by cutting the plug rail with a rail saw or abrasive cutting disk only, 9-feet 6-inches on either side of the insulated joint, which shall result in the proper salvage of a 19-foot long bonded insulated joint plug rail.

3) The installation of standard running rail shall be accomplished by installing a 19-foot minimum length of rail which shall be field welded in.

4) Bonded insulated joint plug rails removed from track shall be salvaged as specified. Bonding shall be installed at locations shown and specified in the Contract Drawings and as specified herein. All components of the track work shall be bonded in accordance with the approved plans. Rail head bonds shall establish electrical continuity and conductive capacity for proper operation of signal system track circuits.

d. Track Alignment and Gauge

1) The installation of plug rails shall not disturb existing vertical or horizontal track alignments, or track gauge. Should the Contractor alter or disturb track alignment or gauge while conducting the work, the track shall be restored to the required Authority tolerances at no additional cost to the Authority.

e. Salvage

1) The Contractor shall recover all bonded insulated joint plug rails and conventional lengths of rail removed from track. This material shall be properly loaded, transported, unloaded and neatly stockpiled at a location to be determined by the Engineer.

f. Testing

1) The insulated plug rail shall be tested prior to and immediately after installation and after final track surfacing. Submit all test results to Project Engineer

2) For all rail-joint bonds where the bond is to be applied, shall be ground clean with a reinforced grinding wheel, of a type as recommended by the bonding material manufacturer. The use of vitrified grinding wheels will not be allowed. After grinding, the surface shall be cleaned with an approved non-toxic solvent to remove all traces of grease and dirt.

3) After the surface has been ground and cleaned, the surface shall be heated to drive out any moisture. The cable bond shall then be welded by the approved exothermic process in such a manner as to ensure a thorough mechanical and electrical connection.

4) The casting of the test specimens shall be by the direct reduction of the exothermic mixture and the flowing of the weld metal into a graphite mold to form the one-half (1/2) inch diameter specimens.

5) At the Contractor's expense and prior to the installation of these bonds, the Contractor shall require each welder to demonstrate, not less than 3 welds or more to achieve satisfactory results, their ability to field weld under conditions similar to those found on the project to determine that the welds are being made properly. Such welds shall be subject to inspection, test and approval by the Engineer, as to the method and quality of workmanship will depend on the results of these inspections and tests.

6) It is of great importance that each rail connection be thoroughly welded to the rail. To reduce the possibility of any of these welds breaking in service, the Engineer reserves the right to require a test of each weld by hammer and striker, or in any other manner which in the opinion of the Engineer is reasonable.

g. Test

1) The Contractor shall demonstrate that the bonding is in accordance with the requirements of this Section, those as shown on the Contract Drawings, and as specified in AREMA C&S Manual, Section 8.

2) Bonds, welds, or connections installed by the Contractor that are found to be defective prior to acceptance, shall be removed and a new bond shall be installed as part of the work.

2. Restraining Rails

a. Place restraining rails adjacent to the gauge side of the inside rail of curves where indicated. Bend the ends of the restraining rails toward the center of the track as indicated.

b. Restraining rail flangeways shall be 1-7/8 inch wide.

c. Drill holes in restraining rails for connection to main rail braces in the field. Burning will not be permitted.

d. Attach main rail braces for restraining rails to every cross tie with 7/8-inch diameter screw spikes as indicated.

3. Restraining Rail Fasteners

a. Pretensioning Fasteners

1) Only use continuous rotation torque wrenches that have been calibrated in conformance with the criteria below.

2) Use all required personal protective equipment (PPE).

3) Clean all surfaces, fasteners, and tools prior to installation.

4) Do NOT lubricate surfaces or fasteners.

5) Using a calibrated torque wrench, apply a torque of 2,275 ft-lbs (Note: This torque is suitable for 1-3/8 inch diameter fasteners only).

6) Do not exceed rated torque for equipment or fasteners.

7) Do not use a torque wrench to break fasteners loose.

8) Do not use broken, heavily worn, or damaged tools.

9) Fasteners used in new construction shall be re-torqued to 2,275 ft-lbs after 1 to 2 weeks of in-service use.

10) Upon installation completion (after re-torquing for new construction), apply matchmarks to clean surface at nut and bolt interface with enamel paint pen. Paint shall be of a color contrasting to the installed fasteners.

11) Keep equipment clean. Ratchet mechanism may slip or break if dirty, which can cause injury or damage.

12) Do not replace worn parts individually.

b. Calibrating Torque Wrenches

1) Calibration of torque wrenches shall be done by MBTA approved calibration laboratory in conformance with ISO 6789:2017.

2) Responsibilities of restraining rail installer (herein referred to as Contractor):
   a) Maintain a calibration log to ensure torque wrenches are properly calibrated.
   b) Maintain a regular calibration schedule not to exceed one year or 5000 uses per unit to ensure that all torque wrenches are calibrated to within ±0.25% accuracy.

c) Ensure that all torque wrenches used for installing restraining rail fasteners are calibrated and logged.
d) Torque wrenches that are found to be out of calibration shall be taken out of service until they have been recalibrated as noted above.
e) Any work that was completed using a torque wrench found to be out of calibration shall be checked and corrected as needed using a properly calibrated torque wrench.
f) Field calibration will not be allowed.

3) Procedures
a) The Calibration Log is used to maintain an accurate record for all calibrated torque wrenches used on MBTA contracts. The Contractor will maintain and utilize the calibration log when sending out a torque wrench for calibration and returning it to service. This allows the Contractor to maintain accountability on all calibrated torque wrenches. The Calibration Log shall, at a minimum, record the following for each torque wrench:
b) The current date, location of stored torque wrenches, page number, and torque wrench serial number.
c) The calibrating company's name.
d) The name of the person who sent the torque wrench to be calibrated (print full name).
e) The Model Type and Model Number as well as the serial number.
f) The date the torque wrench was sent.
g) The drive size of the torque wrench.
h) The date the calibrated torque wrench was returned.
i) The name of the person who received the calibrated torque wrench (print full name).
j) Calibration log shall be made available to MBTA personnel upon request.
k) Contractor shall submit means of field verifying accuracy of torque wrenches for approval. Torque wrenches shall be checked using approved method daily prior to use.
l) Torque wrenches that have not been calibrated using the above procedure shall not be used for installing restraining rails and fasteners.

4. Guard Rails

a. Bend, taper, and fasten guard rails to the cross ties as indicated.

b. Before installing joint bars on the guard rail, clean rail surfaces to be covered by the bars and coat with an oil or grease approved by the Engineer. Tighten bolts to 20,000 - 30,000 pounds tension with a torque wrench.

5. Third Rail

a. Insulators

1) Space third rail insulators as indicated. Install the third rail to rest evenly and uniformly on all insulators within the clearances as indicated. The required relative height of third rail and running rail shall be obtained by using galvanized steel shims or other material of a suitable thickness approved by the Authority fabricated to the outline of the base and installed between the insulator and the third rail tie. Steel shims shall conform to ASTM A526. If rail height is too high, trim the associated tie as required with an adze to be level and smooth for a distance of one foot from the end of the tie. Treat adzed surface with preservative as specified in Article 2.1.D.3. After final adjustment and testing, bend insulator shoulder bands over bottom flange of third rail.

2) Place and position insulators fastened to concrete ties so that the contact rail does not vary in horizontal and vertical alignment, as indicated.

3) Install Teflon inserts on all insulator heads to ensure a uniform elevation and full bearing for the base of the third rail.

4) Stainless steel clips shall be folded down to secure third rail.

b. Joints

1) Bolted Joints: Install third rail bolted joints conforming to Authority-approved design specified under Part 2.2 “Fabrication” and to the installation details indicated.

2) Welded Joints: Weld third rail sections in accordance with manufacturer's instructions and recommendations, as approved by the Engineer.

c. End Approaches

1) Terminate the ends of third rail sections with end approaches except as otherwise indicated. Install approaches in accordance with the Contract Drawings.

2) Install joints to hold the end of rail and end approach in alignment so that on the contact surface, the plane of surface of the jointed third rail and end approach are continuous and true within 1/64 inch.

3) Install bolted joints so that sufficient pressure is exerted to compress the spring lockwashers so that the force between the joint bars and the rail will prevent the joints from working, slipping, or allowing more than 1/64 inch misalignment under service.

4) Install joint bars with bolts, nuts, and spring washers as detailed on the Contract Drawings, between end approaches and adjacent third rail sections. Drill holes in

third rail perpendicular to the surface, straight and true, and reamed. Coat the rail side of joint bars with an approved rust preventive. Joint bars, nuts, bolts, and spring washers shall be hot-dipped galvanized.

d. Anchors: Install third rail anchors as indicated on the Contract Drawings.

J. Special Trackwork

1. Conform to track construction requirements specified herein and as follows.

2. Special trackwork and turnouts shall be constructed at the locations indicated on the Contract Drawings. Dimensions, details and configuration of the special trackwork shall be as indicated. Switch ties shall be placed as indicated. In no case shall the end of a switch tie be within 14 inches of a cut spike, lock spike, or screw spike.

3. The Contractor shall submit a timber plan to the Engineer for approval which shows the proposed timber ties from the frog to the long timbers and from the frog to the switch points for each turnout.

4. All turnout components such as switch points/stock rails, restraining rails, rail joints, and frog castings, shall fit properly and be of the proper match. Both rail ends at all rail joints throughout the turnout and at the joints at the frog shall be matched on both the top (tread portion) and on the gauge side of the rail. Rail end welding, grinding, and slotting shall be performed to achieve a good match, as required. Upon assembling turnouts, all bolted joint holes shall be slotted per AREMA standards.

5. All special trackwork shall be assembled within 0.15 feet of theoretical alignment prior to ballasting work. A bottom layer of ballast shall be placed over the subballast and compacted with a vibratory roller in lifts of not more than 4 inches. The final elevation of the compacted ballast layers shall be not more than 2 inches below the final bottom elevation of the switch timber. Then the timber and steel special trackwork components shall be placed on the compacted ballast and fabricated before final surfacing and alignment of trackwork. Care shall be taken during turnout construction and placement to minimize disturbance to the ballast and subballast.

6. Ballast level in cribs beneath the connecting rod, switch point rails, and switch rods shall be 2 inches below any turnout steel or as directed by the Engineer.

7. Switch machines and targets shall be installed and the switch operating mechanisms adjusted so that the switch operates smoothly, without excessive force being required. All switch plates and connection points in the switch rod shall be cleaned and lubricated with graphite-based lubricant and checked to ensure proper installation and adjustment. All cotter pins shall be installed in upright and connecting rod bolts as well as at the appropriate heel block bolts.

8. Where possible, all turnouts shall be solid box anchored 300 feet beyond the turnout, including both the normal (straight) and reverse (diverging) sides.

9. Space timbers for special trackwork as indicated. Field bore timbers and treat bored holes with coal tar epoxy before spiking or lagging. All spikes shall be fitted with an insulating bushing washer.

10. Install insulating tie plate pads of appropriate size under all plates in turnouts and crossovers. Install rail anchors and track spikes according to the respective patterns indicated.

11. Attach braces to ties with screw spikes.

12. Tamp uniformly and thoroughly in areas of special trackwork, ties, switch timbers, and contact rail support ties to achieve track support equivalent to that provided on the tangent and curved tracks. Use equipment capable of tamping through switches and frogs, as accepted by the Engineer, to effectively stabilize the ballast section in all areas of special trackwork.

13. Install joint bars at indicated locations. Clean and coat rail surfaces to be covered by joint bars with an approved oil or grease to prevent corrosion. When initially installing the joint bars, bring the bolt tension to between 20,000 and 25,000 pounds. For subsequent retightening, bring the bolt tension to between 15,000 and 20,000 pounds.

14. Install insulated joints at locations designated by the Engineer. Install insulated joints after the special trackwork unit has been raised and tamped to final grade and alignment.

15. Make thermite field welds connecting closure rails in accordance with Article 3.7.B.

16. Install buffer rails as indicated.

17. Make all mechanical adjustments and tie spacing as directed by the Engineer prior to final acceptance of special trackwork by the Authority. Spike switches in normal position, using a cut spike, pending installation of switch machines.

0.7 WELDING PROCEDURES

A. Installation of CWR Track

1. Welded Rail Thermal Adjustment

a. General – The Contractor shall destress rail by vibration and thermal adjustment in accordance with the requirements of the Contract Plans and Specifications.

1) Prior to approval of start of work, the Contractor shall participate in a pre-construction working session with representatives from MBTA Design and Construction, Railroad Operations, the Operating Railroad, and MBTA’s designated Resident Engineers to establish the parameters for rail adjustment including the Authority's requirements for performing the work to the satisfaction of the Authority

including all record keeping and timing of such. The Contractor shall be fully prepared to discuss their anticipated plan of work including proposed means and methods and equipment to be used for adjusting CWR.

2) The Contractor shall walk the entire section of track to be destressed, field verifying all existing conditions and dimensions within the limits of the intended work and shall develop a proposed “Detailed Work Plan” to include proposed specific locations of field cuts by track designation, station of cut end of rail string, and right or left rail determined by facing in the direction of increasing stationing. This Plan shall include a detailed schedule with specific strings to be destressed on a day to day basis. The Plan shall be submitted to Authority for review and approval prior to the Contractor commencing the work.

3) Upon approval of established parameters and the overall Plan for rail destressing, the Contractor shall perform their first day of field work in accordance with the methods agreed to at the pre-construction working session which will be closely observed by representatives of the Authority, MBTA Railroad Operations, Operating Railroad, and Resident Engineer to ensure the process is understood and will be done consistently throughout the duration of the Contract.

4) Field cuts in CWR shall be made only after receiving prior approval from the MBTA or Operating Railroad via field review. Contractor shall follow their written plan for handling and moving rail. Move rail as necessary, in such a manner and by use of such equipment that will prevent bumping or striking of rail and will avoid damaging or excessively bending the rail. Lay rail in a manner which will prevent damage to rail, ties, fasteners, and structures. Do not drop rail.

5) The Contractor shall indicate, by marking in white or yellow permanent marker, the string number, ambient temperature, anchoring temperature, and string length, at the end of each installed and destressed string of rail, so that markings face the field side of the rail.

b. Cutting of Rails

1) Cut rails square and clean using a rail saw.

2) Cut rails as outlined below under “Preparatory Work For All Welds.”

c. Procedure

1) Installation and adjustment of CWR shall be per the procedures outlined in the CWR policy, except as modified herein.

2) Prior to cutting rail, determine rail temperature by the procedure outlined in the CWR policy.

3) Contractor shall cut rail at one end of the string to be adjusted, and bypass rail ends to allow string to run without restraint. All clips and/or anchors shall be removed from the rail being adjusted, and the rail shall be vibrated along its entire length to allow it to adjust to ambient temperature.

4) During adjustment of rail, constantly monitor and record rail temperature readings of CWR on the correct form of the CWR policy.

d. Rail Movement and Rail End Gap

1) During thermal adjustment, determine the gap or rail movement between CWR strings and between CWR and bolted rail as outlined in the CWR policy. The desired temperature (Dt) of the CWR strings at the time of anchoring shall be 100°F with an allowable range of 90°F to 110°F.

2. Anchoring of CWR

a. General

1) Install rail clipping devices as specified herein and in accordance with manufacturer's recommendations.

b. Rail Anchoring Temperature

1) Anchor rail at 100°F, with allowance for ± 10F°. When zero thermal stress temperature is obtained and proper movement has been obtained at the quarter point mark, begin anchoring. The movement of rail is more important than the rail temperature at time of anchoring. Rail temperature shall remain within specified zero thermal stress range until rail is fully anchored. If rail temperature deviates from specified zero thermal stress range, cease anchoring until rail temperature returns to within specified range.

2) When rail temperature is below zero thermal stress temperature range, an approved rail heating device shall be used for expanding CWR to make proper adjustments. When this heating method is employed, anchoring operations shall begin only after proper movement has been obtained at the quarter point mark immediately behind said heater.

3) During anchoring, it is necessary to ensure uniform expansion. To control this, mark the quarter points of strings on a rail and tie plate, using a metal marker, paint pen or approved equivalent, so that the amount of expansion can accurately be determined, then make sure each string of rail expands as follows:

1/4 Point – 1/4 of Required Expansion

1/2 Point – 1/2 of Required Expansion

3/4 Point – 3/4 of Required Expansion

End Point – All of Required Expansion

4) In the event that the first quarter or any quarter of the heated string does not have the required expansion, back the heater up – without applying heat to the rail – and reheat and vibrate until proper expansion is obtained in the quarter.

5) Record rail temperature and related information during the rail clipping process. The Authority provided 'Destressing Record Form', found at the end of this specification section, shall be used for recording this information and shall be completely filled out and signed by the Contractor and submitted to the Authority each day prior to the track being accepted and returned to service.

c. Zero Thermal Stress

1) Install, anchor, join, and field weld CWR to produce zero thermal stress in rail at 100°F, with an allowance of ± 10F°.

2) Zero thermal stress may be achieved by heating. Methods for artificially obtaining zero thermal stress must be acceptable to the Authority. Take care to prevent damage to trackwork components during heating process. If damage occurs, repairs shall be made at no additional cost to the Authority.

3) Vibrate rail during thermal adjustment to relieve internal rail stresses. Continue vibration during full period of rail length correction. Mechanical vibrators used for relieving internal rail stress shall be of a type acceptable to the Authority and shall not damage the CWR or other track components. All CWR shall be vibrated as part of the destressing process.

4) Follow specified requirements for destressing rail, and procedures shown in the MBTA CWR Plan which is included in this Section as Attachment A.

3. Rail Fastening

a. Rail anchors shall be replaced in kind. Used anchors shall be collected and made available to the Authority. Any rail fasteners encountered in the course of the work shall be reused or replaced in-kind.

b. Rail clipping (anchoring) shall commence immediately after the rail has achieved the required expansion and immediately following the rail heater if that method is used to achieve rail expansion. All anchors installed shall be new.

c. Anchors shall be as specified under Article 2.1.M.

d. Adjusted CWR rail shall be properly clipped/anchored per the quantities and patterns specified in MBTA RR Operations Standards: MW-1 and the CWR Plan. The Contractor shall be responsible for providing adequate quantities of rail clips/anchors so that the requirements of these Standards are fully met.

4. Rail Welding

a. Immediately after thermal adjustment is completed, rail shall be field welded and ultrasonically inspected prior to returning the track to service.

b. When immediate welding of joints is not practical, said joints will be bolted per all applicable parts of MBTA RR Operations MW-1 and the CWR Plan, until that time when joint welding is performed.

5. Required Contractor Equipment

a. The Contractor shall submit to Authority for review their proposed on-track/hi-rail equipment which shall consist of the following at a minimum:

1) One (1) self-propelled dual sided rail heater/vibrator with 32-burners or two (2) self-propelled equivalent single rail heater/vibrators by Flink Company, Teleweld or approved equal.

2) One or more hi-rail boom trucks (grapple loader or equivalent) to enable timely transport and installation of spare rail and clipping/anchoring materials and small track equipment.

3) Hi-rail mobile rail welding unit with all necessary tools and equipment.

The Contractor will not be allowed to commence field destressing work until the on-track/hi-rail equipment meeting these requirements has been approved by the Authority.

B. Welding of Rail

1. Preparatory Work For All Welds

a. Rail, which must be cut for any reasons shall be cut square and clean by means of rail saws or abrasive, cutting wheels in accordance with AREMA Manual, Specifications for Steel Rails, Chapter 4, Part 2, Section 2.1. Torch or flame cutting of rails is prohibited. Rail ends not within 1/32-inch of square shall be cut square.

b. Rails shall conform to the AREMA Manual, Specifications for Steel Rails, Chapter 4, Part 2, Section 2.1 for straightness. Rail ends shall show no steel defects, dents or porosity before welding.

c. Rails shall be straightened cold in a hydraulic press or roller machine to remove twists, waves, and kinks until they meet the

surface and line requirements specified herein. The method of permanent straightening shall be submitted to the Engineer for approval.

d. Rail that cannot be straightened permanently shall be cut back a distance sufficient to achieve the required alignment. Burrs shall be removed. The method of end finishing rails shall be such that the rail end shall not be metallurgically or mechanically damaged.

e. The leading edge of any bond wire connections or holes of any type shall not be within 6-inches of the centerline of a completed weld of any type, regardless of the order of installation.

If present, cut rail a minimum of 9-inches back of a burned hole or a bond wire connection and 1-inch back of a drilled hole. Cut rails square and clean using a rail saw.

2. Fabrication of Welded Rail Strings

a. Welded rail strings shall be of the longest lengths practical to fabricate and handle. String length shall not be less than 400 feet except as required by joint location.

1) The schedule shall indicate the locations of proposed field cuts, if any. The rail schedule shall minimize thermite welds between standard rails and high strength rails.

b. Join rails with flash butt welds to form CWR. Join strings of CWR with flash butt or thermite welds, as approved by the Engineer.

3. Flash Butt (Pressure) Welding

a. Electric Flash Butt welding shall be in accordance with the AREMA Manual, Specifications for Fabrication of Continuous Welded Rail, Chapter 4, Part 3, Section 3.11 except as modified hereinafter.

b. The Contractor shall provide designated qualified individuals to perform fire watch during the performance of pressure welding. Fire watch personnel shall be supplied with water tanks and sprayers sufficient to prevent smoldering ties from catching flame.

c. The contractor shall exercise special care during welding to prevent damage to existing insulated joints. Any insulated joints damaged during welding processes shall be replaced by the Contractor at no additional expense to the Authority.

d. Mismatched or jagged rail ends shall be either sawed or cut with an abrasive rail cutter. Mating rail ends by flashing shall not be accepted.

e. Rails shall have the scale removed down to bright metal in areas where the welding current-carrying electrodes contact the rail. Grind down raised rail brands in electrode areas. The weld and adjacent rail for a distance clearing the electrodes shall be rejected if in the areas of electrode contact there is not more than 95 percent of the mill scale removed. Electrode contact

areas shall be examined for evidence of electrode burn. Where metal is displaced or where the oxidized areas exhibit checks or small cracks, the weld shall be rejected and the rail cut back clear of the electrode burn.

f. Welds shall be forged to point of refusal to further plastic deformation and shall have a minimum upset of 1/2-inch, with 5/8-inch as standard.

g. If flashing on electric pressure (flash butt) welds is interrupted, because of malfunction or external reason, with less than 1/2-inch of flashing distance remaining before upsetting, rails shall be re-clamped in the machine and flashing initiated again.

h. Whenever possible, grinding shall be accomplished immediately following welding at an elevated temperature. When grinding must be done at ambient temperature, care shall be taken to avoid grinding burns and metallurgical damage.

i. Alignment of rail in the welding machine shall be at the head of the rail.

    1) Vertical alignment shall provide for a flat running surface. Any difference of height of the rail shall be in the base.

    2) Horizontal alignment shall be accomplished in such a manner that any difference in the width of heads of rails shall be divided equally on both sides of the head. Where the difference, when divided, exceeds 0.040 inches, 0.020 inches of the difference shall be placed on the gauge side and the remaining differences in the width of heads shall be on the field side.

    3) Horizontal offsets shall not exceed 0.040 inch at the head and/or 0.125 inch at the base.

j. Surface and Gauge Misalignment Tolerances: Shall meet the alignment tolerances given in the AREMA Manual, Tolerances for Inspection of Welded Rail New and Main Line Relay Rail, Chapter 4, Part 3.11, Figure 4-3-22.

k. If, at any time, 7 or more of a series of 12 consecutive welds made on one machine exceed 75 percent of the stated surface misalignment tolerances that machine shall be shut down and adjusted before work continues.

l. Re-welds shall be cut out beyond the heat affected zone of the previous weld.

m. Weld Finishing:

    1) A finishing deviation of the parent section of the rail head surface shall not exceed plus 0.010 inch of the lowest rail.

    2) The sides of the rail head weld shall be finished to ± 0.010 inch of the parent section. The top and bottom of the rail base shall be finished to ± 0.010 inch of the lowest rail.

3) The web zone including the underside of the head, the web, and both fillets on each side, shall be finished to within plus 0.090 inch to plus 0.010 inch of the parent section. Finishing grinding shall eliminate all cracks.

4) Notches created by minor offset conditions, twisted or misshapen rails shall be eliminated by minimal grinding to blend the variations.

5) Fins on the weld due to grinding or shear drag shall be removed prior to final inspection.

n. One handling hole may be made in each end of a CWR string. Rail ends containing such holes shall be cut off during track construction as indicated.

4. Production, Inspection, and Testing of Pressure Welds

a. A chart recorder shall be used to monitor all significant welding parameters. The recorder shall identify each weld in each string. In addition, the rail schedule designation for each string shall be included on the recording with a notation to indicate the beginning and ending of each CWR string. Each recorder employed shall be calibrated daily. Recordings shall become the property of Authority at the time the welded rail is released for installation.

b. Inspect all pressure welds by the dry powder magnetic particle method in accordance with ASTM E709.

c. Inspect all pressure welds in accordance with AREMA Manual requirements.

d. Defective pressure welds shall be repaired immediately during production. Other defective weld findings shall be repaired as specified in Article 3.7.B.7, Repair of Defective Welds.

e. Hardness - The hardness of the weld measured on the head of the rail in the center of the weld shall be equal to the Brinell hardness of the parent metal with a tolerance of ± 20 Brinell hardness numbers. Brinell Hardness testing shall be conducted only on test welds by an approved Testing Technician.

f. Weld testing shall be carried out by an independent testing laboratory. The testing service and their testing program and procedures are subject to approval as specified herein.

g. The testing service shall certify whether or not each weld meets the quality acceptance criteria detailed and shall submit reports. At the time of testing the testing service shall mark their findings as to acceptability or rejection on the weld itself.

h. Identifying Pressure Welds and Rail Strings: At the completion of welding each string of CWR, a record shall be submitted documenting production of the string. Included shall be the heat numbers of the first and last pieces of rail in the string, the number of welds in the string, the heat numbers of rail on each side of welds which have been cut out and re-welded, a record of

machine performance for each weld, and reports for all testing. Reports shall be bound in pad or notebook form for ease of handling and retention as permanent record.

5. Production, Inspection, and Testing of Thermite Welds

   a. Electric flash butt welds are preferred by MBTA. The use of thermite welds shall be considered on a location by location basis subject to approval by the Engineer.

   b. Except at Special Trackwork locations with approval by the Engineer, thermite welds shall not be located within the following location:

      1) Within 15 feet of a field weld in the same rail.

      2) Within 15 feet from the center of any bolted or bonded (glued) joint.

      3) Within 10 feet of a transition from embedded or direct fixation track to ballasted track.

      4) Within 5 feet of an electric flash butt weld.

      5) Within 25 feet of a bridge or grade crossing.

      6) Within 2 feet of a thermite weld in the opposite rail.

      7) Within 9 inches of a weld which has been cut out

      8) Within 6 inches of a bolt hole.

      9) Over or within 5 inches of a tie plate or concrete tie rail seat.

   c. Bolt holes and handling holes shall not be permitted to remain within 6 inches of a rail weld regardless of installation methodology. Rail ends containing such holes shall be cut off during track construction.

   d. Preparation of Rail Ends: Rail ends shall be either saw-cut or ground at right angles to the rail to provide a smooth and clean surface. The surface of the rails for a length of approximately 6 inches from the end of the rails shall be cleaned by grinding to remove all grease, dirt, loose oxide, oxidized metal, scale, and moisture. All burrs and lipped metal which would interfere with the fit of the mold shall be removed.

   e. Weld Gap: At the time of thermite welding, the rails shall have the rail gap recommended by the manufacturer of the weld kit and shall be aligned to produce a weld which, with respect to alignment, shall comply with the AREMA Manual. Should the rail gap be larger than the manufacturer's recommended gap after the rails have been adjusted for zero thermal stress, then sufficient rail shall be removed from one or both rails to permit insertion of a rail not less than 19 feet long which shall provide the recommended gaps at each end for field welding. At a location where the rail gap is smaller than the manufacturer’s recommended gap, the recommended gap shall be obtained by sawing and removing a piece from one rail.

f. The Contractor shall provide designated qualified individuals to perform fire watch during the performance of pressure welding. Fire watch personnel shall be supplied with water tanks and sprayers sufficient to prevent smoldering ties from catching flame.

g. The contractor shall exercise special care during welding to prevent damage to existing insulated joints. Any insulated joints damaged during welding processes shall be replaced by the Contractor at no additional expense to the Authority.

h. Thermite Weld Preheating - The rail ends shall be pre-heated prior to welding to a sufficient temperature and for sufficient time as indicated in the approved welding procedure to ensure full fusion of the weld metal to the rail ends without cracking of the rail or weld.

i. Thermite Weld Postheating - The molds shall be left in place after tapping for sufficient time to permit complete solidification of the molten metal and proper cooling to prevent cracking and provide a complete weld with proper hardness and ductility.

j. Weld Finish: Rail shears shall be used to trim upset weld metal from the rail after removal of the mold. Trimming and grinding of the weld shall result in the weld being within the following tolerances:

    1) The top, field, and gauge sides of the rail head shall be finished to within ± 0.010 inch of the parent section.

    2) The bottom and sides of the rail base: finished within plus 0.030 inch or minus 0.000 inch of the lower rail base if the weld is on, or within three inches of the edge of a rail support.

    3) The web zone (the remainder of the rail): finished to plus 0.125 inch or minus 0.000 inch of the parent section. Finishing shall eliminate visible cracks.

    4) Notches created by offset conditions shall be eliminated by grinding to blend variations. Protrusions and gouges in the welded area shall be removed, and the weld area shall be blended into the rail contour by grinding in a manner which will eliminate fatigue crack origins. Defects visible to the unaided eye shall be removed by grinding, except that if removal by grinding cannot be accomplished without damaging the rail, the weld shall be removed. Grinding pressure which would overheat the rail surface shall not be permitted.

    5) Heavy grinding of the weld shall be completed while the weld is still hot from welding.

k. Inspect all thermite welds in standard track and all thermite welds in each item of special trackwork ultrasonically in accordance with Article 1.3.R.4.d herein before.

l. Defective thermite welds, as specified in Article 3.7.B.6, Defective Thermite Welds, shall be repaired as specified in Article 3.7.B.7, Repair of Defective Welds.

m. Inspect all thermite welds by magnetic particle, testing only the head of the rail and in accordance with Article 1.3, Quality Assurance.

6. Defective Thermite Welds

a. Defective thermite welds shall be defined as follows:

1) Weld quality or finishing alignment not in accordance with above-referenced standards.

2) Welds showing a response at any level that is identified as a crack or lack of fusion.

3) Welds showing a response that exceeds the primary reference level.

4) Welds showing a response greater than 50 percent of the primary reference level provided that one of the following conditions also applies:

a) The defects are not evaluated as slag or porosity.

b) The largest defect exceeds 0.180 inch as its largest dimension

c) The total area of the defects exceeds 0.009 square inch.

d) The sum of the greatest dimension of defects in a line exceeds 0.375 inch.

7. Repair of Defective Welds

a. Pressure welds rejected during final track inspection or testing by Rail Defect Car shall be cut out and rewelded, if possible, or replaced with at least a 19-foot rail welded in its place by two thermite welds in accordance with this specification.

b. Thermite welds rejected during inspection or testing shall be cut out and rewelded, if possible, or replaced with at least a 19-foot rail welded in its place by two thermite welds in accordance with this specification.

c. Special Thermite Welds

1) Should a defective thermite weld replacement using an inserted piece of rail and two welds not be practical because of limitations due to adjacent special trackwork parts, the Contractor shall cut out the defective weld and replace it with a special wide thermite weld as approved by the Engineer. Prior to use in track this special weld shall be tested and accepted as in Article 1.3 above.

0.8 NOISE AND VIBRATION MITIGATION

A. Preparation

1. Construction of the track subgrade and subballast layers shall be completed as shown on the Contract Drawings. The ballast mat shall be a minimum of 12-feet in total width for each track installation. All mat joints shall be perpendicular to the design track centerline. Filter fabric as specified by the Engineer shall be placed at the edge of ballast mat to prevent penetration of fine particles under the ballast mat.

    a. Contractor shall develop sketch plans and submit to the Engineer for review and approval. Sketch plans shall include, but not be limited to, typical cross-sections through track showing:

        1) Length of ballast mat to be installed.

        2) Detail of placing and wrapping geotextile at the edge of the ballast mat to minimize infiltration of fine-grained materials.

        3) Detail of proposed joints in ballast mat and geotextile. Joints in ballast mat and geotextile shall be installed per manufacturer’s recommendations.

    b. Develop typical details in plan to show:

        1) Placement of ballast mat to show width of mat and location and details of proposed joints.

        2) Placement of geotextile to show width of geotextile at mat edges and location and details of proposed joints.

B. Ballast Mat Installation

1. Prior to installation of the ballast mat, the substrates shall be thoroughly cleaned of all debris and dust. Rough or uneven areas shall be removed until the surface is made acceptable to the Engineer.

2. Unroll ballast mat from reels positioned close to point of installation in accordance with approved procedure and as directed by the manufacturer's representative. Edges shall be cut straight and smoothly to assure a uniform fit at all joints, tapered at trackway curves, and at ends which shall be sealed as recommended by the manufacturer.

3. Secure ballast mat at all seams as recommended by the manufacturer providing a water-tight seam at abutting mats. Means and methods for obtaining water-tight seam shall be provided by manufacturer for review by the Engineer.

4. At all times, exercise extreme care to prevent intrusion of silt and debris into the void space provided under the mat. The joints shall be protected and galvanized steel strips shall be placed over the edges of the ballast mat as soon as the mat is installed in accordance with manufacturer’s recommendations. At no time shall water, silt, and debris be allowed to enter into newly-installed ballast mat from the

trackway or from other sources. Temporary positive seals shall be installed along the open edges of the mat to prevent such intrusion. Permanent seals with approved mastic shall be installed on the open edges of the ballast mat.

5. Ballast mats contaminated with silt and debris shall be removed, cleaned, and reinstalled or replaced with new materials at no additional cost.

6. Place a caulking sealant compatible with the ballast mat as recommended by the manufacturer at all outside edges, mat joints where the mat interfaces concrete, and/or steel surfaces to assure water-tightness.

7. Damaged mats shall be repaired or replaced at no additional cost.

C. Placement of Track Ballast

1. Ballast stone shall not be transported across the ballast mat. Trucks and any other construction equipment shall not operate on the ballast mat unless it is covered with at least 6 inches of track ballast.

2. Track construction will be permitted in area of ballast mat only after an initial minimum 10-inch layer of bottom track ballast has been distributed, graded, compacted, and approved by the Engineer.

3. Terminate ballast mat edges at abutments with double layers of geotextile filter fabric securely placed on the ballast mat edge by overlapping at least 18 inches.

0.9 FINAL TRACK INSPECTION

A. Final horizontal and vertical alignment, gauge, superelevation, and cross level shall be within the tolerances specified in this Section throughout the areas worked on as shown on the Contract Drawings. In addition, tests shall be made for rail and weld defects in the completed track. In order to determine the acceptability of finished track, the Contractor, together with the Engineer, shall conduct the following tests and procedures to establish that track construction is within tolerances specified herein and free of defects:

1. Track deviations and defects disclosed by inspection and which exceed tolerances specified herein shall be corrected by the Contractor at no additional cost to the Authority. Re-inspections shall be made by the Contractor and the Engineer to ensure that corrections have been made.

2. Final inspection of geometric parameters will include testing by an approved track geometry test car capable of testing gauge, cross-level, left and right rail profiles, track alignment, twist, warp, and superelevation. Test car shall be capable of measuring the parameters specified above with sufficient accuracy to establish that the track construction is within the specified tolerances.

3. The Contractor shall correct track deviations, as disclosed by final inspection, at no additional cost to the Authority.

4. The Contractor shall retest areas re-worked as a result of corrections at no additional cost to the Authority.

5. After all geometric testing and corrections have been completed, new rail installed shall be ultrasonically tested with on-track equipment. The equipment shall be capable of detecting internal rail flaws and defective welds. The identified defects shall be marked with paint and records indicating location of the defects by engineering station and the type of defect shall be provided to the Engineer.

6. As directed by the Engineer, defects in rail and welds shall be cut out and new rail plugs of the same type of rail welded into track. Plugs shall meet or exceed the minimum length outlined in the CWR policy and shall be of sufficient length to ensure that the welds will be no less than three feet from the ends of the removed defect or nearest weld.

7. During replacement of defects, Contractor shall follow all precaution and methodology defined in Article 3.7 to maintain zero thermal stress temperature in the rail and take whatever actions necessary to restore rail to the required stress range.

8. After completion of the corrective field welds, they shall be tested in accordance with Article 1.3.R.4.

PART 4 - MEASUREMENT AND PAYMENT

0.1 MEASUREMENT

A. Trackwork of the various types shown on the Schedule of Bid Prices will be measured by the linear foot, horizontally along the centerline of track.

B. Subgrade preparation will be measured for payment as specified for fine grading in Section 02300 - EARTHWORK.

C. Ballast mats will be measured by the square yard, installed.

D. Subballast will be measured by the cubic yard, complete in place.

E. Herbicide will be measured by the acre, applied.

F. Third rail will be measured by the linear foot of the third rail installed exclusive of end approaches, as determined from the approved shop drawings.

G. End approaches will be measured by the actual number of end approaches provided as determined from the approved shop drawings.

H. Turnouts and crossovers of the various types shown on the Schedule of Bid Prices will be measured by each unit within the limits indicated.

0.2 PAYMENT

A. Trackwork of the various types shown on the Schedule of Bid Prices will be paid for at the respective Contract price per linear foot, which price shall include full compensation for doing all work to provide trackwork, complete in place as indicated, including ballast as indicated, but excluding preparing subgrade, subballast, furnishing and installing turnouts and crossovers, and Authority-furnished materials.

B. Ballast mats will be paid for at the unit price per square yard, which price shall include full compensation for doing all work involving installing ballast mats, complete in place.

C. Subballast will be paid for at the Contract price per cubic yard, which price shall include full compensation for doing all work involved with installing subballast, complete in place, but excluding subgrade preparation.

D. Herbicide will be paid for at the Contract price per acre, which price shall include full compensation for doing all work involved in applying herbicide, complete in place, except for the addition of contact herbicide, as indicated.

E. Turnouts and crossovers will be paid for per unit for the various types shown on the Schedule of Bid Prices, which price shall include full compensation for doing all work to provide the unit, complete in place as indicated, but excluding subgrade preparation.

F. Third rail without end approaches will be paid for at the price per linear foot, which price shall include furnishing and installing composite third rail, joint bars, insulators, anchors, and all necessary and incidental materials required for the third rail, exclusive of the end approaches.

G. Third rail in Special Work without end approaches will be paid for at the price per linear foot, which price shall include furnishing and installing composite third rail joint bars, insulators, anchors, and all necessary and incidental materials required for the complete installation of the third rail, exclusive of the end approaches.

H. End approaches will be paid for at the unit price per end approach, which price shall include furnishing and installing end approaches, including joints, insulators, anchors, and all necessary and incidental materials required for the installation of the third rail end approaches.

0.3 PAYMENT ITEMS

ITEM NO.	DESCRIPTION	UNIT
0226.021	HERBICIDE	AC
0222.587	BALLAST MAT	SY
0222.610	SUB-BALLAST	CY
0290.013	NEW RAIL	LF
0291.136	SPECIAL TRACKWORK - NO. 6 TURNOUT	EA
0292.015	TANGENT AND CURVED TRACK	LF
0291.524	THIRD RAIL END APPROACH	EA

RECORD OF FIELD WELDS

DATE:_____**TIME:**_____

TRACK DESIGNATION:_____

LOCATION: FROM STA./MP_____**TO STA./MP**_____

RAIL TO BE WELDED: OUTBOUND LEFT____ **OUTBOUND RIGHT**____

RAIL SECTION:_____**OTHER:**_____

MILL BRAND:_____

YEAR ROLLED:_____**(AHEAD)**_____**(BACK)**

HEAT NUMBER:_____**(AHEAD)**_____**(BACK)**

TYPE OF RAIL: HEAT-TREATED CONTROL-COOLED
(CIRCLE)

RAIL CUT REQUIRED:____**(YES)**__**(NO)**_____
IF YES: TOTAL AMOUNT REMOVED:_____

MANUFACTURER – MACHINE NO. :_____

AIR TEMPERATURE:_____

RAIL TEMPERATURE:_____

WEATHER CONDITION:_____

TRACK ALIGNMENT AND CONSTRUCTION:_____
(Degree of Curve, Tangent, Grade, Etc.)

NAME OF ENGINEER OR REPRESENTATIVE PRESENT:_____

NAME OF CONTRACTOR'S FOREMAN PRESENT:_____

MBTA RESIDENT ENGINEER/INSPECTOR:_____

INSPECTION

PHYSICAL	VERTICAL	HORIZONTAL	ULTRASONIC	MAGNAFLUX	GRINDING

INSTRUCTIONS: Use “OK” to indicate inspection was made and weld passed for physical, ultrasonic, magnaflux and grinding. Write number in thousandths of an inch measured for vertical and horizontal.

END OF SECTION

MBTA TRANSIT RAIL DESTRESSING RECORD FORM

TRACK ID: **STRING NO:**

DATE:	**WEATHER:** (TEMP,CLOUD)	**INITIAL RAIL TEMP (T)(°F):** (Average of Three Readings Over Length of Rail on
STRING LOCATION:	BEGINNING CM:	ENDING CM:
TRACK: NB [ ] SB [ ] EB [ ] WB [ ] LR [ ] RR [ ]	**RAIL:** E [ ] W [ ] N [ ] S [ ]	IF MATTAPAN LINE: IB [ ] OB [ ]

TO BE COMPLETED WHEN INITIAL RAIL TEMP IS LESS THAN 90 OR MORE THAN 110 DEGREES

Rail has been fully unclipped/relaxed to ambient temperature prior to marking quarter points: [ ] Foreman

EXPANSION POINTS:	**0**	**1/4**	**1/2**	**3/4**	**END**
RAIL EXPANSION CALCULATED: (MIN 90 °F) ΔR_{L90}(IN) = R_L(FT) x (90 – T)(°F) x 0.000078					
RAIL EXPANSION CALCULATED: (TARGET 100 °F) ΔR_{L100}(IN) = R_L(FT) x (100 – T)(°F) x 0.000078					
RAIL EXPANSION CALCULATED: (MAX 110 °F) ΔR_{L110}(IN) = R_L(FT) x (110 – T)(°F) x 0.000078					
RAIL EXPANSION ACTUAL: ΔR_{LA} = Measured Values					
CALCULATED RAIL NEUTRAL TEMPERATURE (RNT): RNT = T + (ΔR_{LA}(IN)* / (R_L(FT) x 0.000078))					

METHOD OF EXPANSION: HEATED [ ] COOLED [ ] STRETCHED [ ] **VIBRATED:** YES [ ] NO [ ]

TO BE COMPLETED WHEN INITIAL RAIL TEMP IS BETWEEN 90 AND 110 DEGREES (NATURAL DE-STRESSING ONLY)

RECORDED AT ANCHORING LOCATION (every 100')

CHAIN MARKER	TIME	RAIL TEMP (°F)

AVERAGE RAIL TEMPERATURE:

TIME ANCHORING STARTED: am/pm **COMPLETED:** am/pm

FOREMAN: _____

(PRINT NAME) (SIGNATURE)

REVIEWED BY:

(ROADMASTER - SIGN) (DATE)

(SENIOR ENGINEER - SIGN) (DATE)

MBTA MAINTENANCE OF WAY HI-RAIL INSPECTION REPORT

Vehicle Information

Date: _____

Owner: _____

Description: _____

Year: _____

Make/Model: _____

Reg. (State/No.) _____

Access Approved: (check all that apply) ☐ RL ☐ OL ☐ BL ☐ GL

Contact Name: _____

Contact Phone: _____

Inspection Criteria	MEASURED	ACCEPTED YES	ACCEPTED NO	COMMENTS
Steering wheel lock: (mechanical lock required if front tires contact running rail)		☐	☐	
Diesel: (gasoline vehicles permitted in open air only)		☐	☐	
Max height: (11'-6" max height for tunnel access)		☐	☐	
Front wheel O/S from gage line - 3rd rail territory only: (14" max, if >14", tires must ride 9" min above running rail)		☐	☐	
Rear wheel O/S from gage line - 3rd rail territory only: (14" max)		☐	☐	
Hi-rail wheel back to back dimensions front/rear: (Red/Orange/Blue = 4.45' - 4.47', Green = 4.51' - 4.53')		☐	☐	
Hi-rail wheel gage corner to gage corner dimensions front/rear: (Red/Orange/Blue = 4.64' max, Green = 4.68' max)		☐	☐	
Backup alarm:		☐	☐	

Operating Restrictions (check all that apply)

☐ 3 MPH MAX THROUGH SPECIALWORK WITH GROUND SPOTTER	☐ NO RESTRAINED CURVES
☐ NO THIRD RAIL TERRITORY	☐ NO DOUBLE RESTRAINED CURVES
☐ NO TUNNEL ACCESS	☐ TRAVEL WITH BOOM HORIZONTAL
☐ 3 MPH THROUGH GRADE CROSSINGS WITH GROUND SPOTTER	☐ NO TURNOUT MOVES
☐ REMOVE OUTER WHEELS PRIOR TO ACCESS	☐ TRAVEL WITH BUCKET/PLATFORM IN STOWED POSTION
☐ GROUND SPOTTER REQUIRED FOR TIGHT CLEARANCE AREAS	☐ SAFETY CHAINS REQUIRED BETWEEN UNITS
☐	☐

Certification

Certificate No. _____

Expiration Date _____

Engineer _____

Certification History

Certificate No.	Date Issued

Contractor Acknowledgement

Owner/contractor maintain responsibility for overall safety and mechanical function of vehicle and rail gear in accordance with applicable regulations.

The MBTA reserves the right to deny/revoke certification and restrict equipment access to MBTA property at any time.

SIGN: _____

NAME/DATE: _____

O:\AR-MAOFWAZ\Hi-Rail Vehicle Clearance Inspections\Forms\ Rev. 02-2024